N00204.AR.004170
NAS PENSACOLA
5090.3a

REMEDIAL ACTION PLAN FOR SITE 20 ALLEGHENY PIER 303 WITH TRANSMITTAL LETTER NAS PENSACOLA FL
9/1/2002
TETRA TECH

TETRA TECH NUS, INC.
800 Oak Ridge Turnpike, A-600 ▪ Oak Ridge, Tennessee 37830
(865) 483-9900 ▪ FAX: (865) 483-2014 ▪ www.tetratech.com

0902-E341

September 27, 2002

Project Number 0516

Ms. Tracie Vaught
Remedial Project Manager
Technical Review/Federal Facilities
Florida Department of Environmental Protection
2600 Blair Stone Road
Tallahassee, Florida 32399-2400

Reference: Clean Contract No. N62467-94-D-0888
Contract Task Order No. 0112

Subject: Final Remedial Action Plan for Site 20, Allegheny Pier (Pier 303), Naval Air Station Pensacola, Pensacola, Florida

Dear Ms. Vaught:

Tetra Tech NUS, Inc. is pleased to submit for your review the Final Remedial Action Plan for Site 20 Allegheny Pier (Pier 303), Naval Air Station (NAS) Pensacola, Pensacola, Florida. This document has been prepared for the U.S. Navy Southern Division, Naval Facilities Command under CTO 112 for the Comprehensive Long-term Environmental Action Navy Contract N62467-94-D-0888.

If you have any questions, please call me at (850) 385-9899.

Sincerely yours,

Michael F. Albert for

Gerald Walker, P.G.
Project Manager

GAW/gaw

Enclosure

c: Mr. Byas Glover, SOUTHDIV
Mr. Greg Campbell, NAS Pensacola PWC
Ms. Debbie Wroblewski (Cover letter only)
Mr. Michael Albert, P.E., Tetra Tech
Mr. Mark Perry, Tetra Tech
TtNUS File, Tallahassee
TtNUS library, Tallahassee

REMEDIAL ACTION PLAN

for

SITE 20

ALLEGHENY PIER (PIER 303)
NAVAL AIR STATION PENSACOLA
PENSACOLA, FLORIDA

Southern Division
Naval Facilities Engineering Command
Contract Number N62467-94-D-0888
Contract Task Order 0112

September 2002

PROFESSIONAL ENGINEER CERTIFICATION

I hereby certify that this document, *Remedial Action Plan for Site 20, Allegheny Pier (Pier 303), Naval Air Station Pensacola, Pensacola, Florida* was prepared under my direct supervision. The work and professional opinions rendered in this report were conducted or developed in accordance with commonly accepted procedures consistent with applicable standards of practice.

Tetra Tech NUS, Inc.
800 Oak Ridge Turnpike, Suite A-600
Oak Ridge, Tennessee 37830
Certificate of Authorization No. 7988

Michael F. Albert
Professional Engineer
State of Florida License No. 55239

Michael F. Albert
9/27/02

REMEDIAL ACTION PLAN

FOR

SITE 20
ALLEGHENY PIER (PIER 303)
NAVAL AIR STATION PENSACOLA
PENSACOLA, FLORIDA

COMPREHENSIVE LONG-TERM
ENVIRONMENTAL ACTION NAVY (CLEAN) CONTRACT

Submitted to:
Department of the Navy, Southern Division
Naval Facilities Engineering Command
2155 Eagle Drive
North Charleston, South Carolina 29406

Submitted by:
Tetra Tech NUS, Inc.
661 Andersen Drive
Foster Plaza
Pittsburgh, Pennsylvania 15220

CONTRACT NO. N62467-94-D-0888
CONTRACT TASK ORDER 0112

SEPTEMBER 2002

PREPARED UNDER THE SUPERVISION OF:

Gerald Walker

GERALD WALKER
TASK ORDER MANAGER
TETRA TECH NUS, INC.
TALLAHASSEE, FLORIDA

APPROVED FOR SUBMITTAL BY:

Debra M Wroblewski

DEBBIE WROBLEWSKI
PROGRAM MANAGER
TETRA TECH NUS, INC.
PITTSBURGH, PENNSYLVANIA

TABLE OF CONTENTS

TABLE OF CONTENTS (Continued)

SECTION **PAGE**

TABLE OF CONTENTS (Continued)

APPENDICES

TABLES

FIGURES

ACRONYMS

AFVR	aggressive fluid vapor recovery
API	American Petroleum Institute
bls	below land surface
BTOC	below top of casing
cfm	cubic feet per minute
CLEAN	Comprehensive Long-Term Environmental Action Navy
COC	chemical of concern
COI	chemical of interest
COPC	chemical of potential concern
CTL	cleanup target level
CTO	Contract Task Order
DO	dissolved oxygen
DOT	Department of Transportation
DPT	Direct Push Technology
DSCFM	dry standard cubic feet per minute
EDB	ethylene dibromide
ECUA	Escambia County Utilities Authority
F.A.C.	*Florida Administrative Code*
FDEP	Florida Department of Environmental Protection
FID	flame ionization detector
GAC	granular activated carbon
GCTLs	groundwater cleanup target level
HI	Hazard Index
HQ	Hazard Quotient
LUC	land use control
MSW	marine surface water
MTBE	methyl tertiary butyl ether
NAS	Naval Air Station
Navy	United States Navy
NCDENR	North Carolina Department of Environment and Natural Resources
NEESA	Navy Energy and Environmental Support Activity
NPDES	National Pollutant Discharge Elimination System
NPWC	Navy Public Works Center
O&M	Operation and Maintenance
ORC®	Oxygen Reducing Compound

ORP	oxidation reduction potential
OVA	organic vapor analyzer
PAHs	polycyclic aromatic hydrocarbon
PID	photoionization detector
POTW	publicly owned treatment work
ppb	parts per billion
ppm	parts per million
RAP	Remedial Action Plan
RPM	Remedial Project Manager
SAR	Site Assessment Report
SARA	Site Assessment Report Addendum
SCTLs	soil cleanup target level
STP	standard temperature and pressure
T&D	transport and disposal
TRPHs	total recoverable petroleum hydrocarbons
TtNUS	Tetra Tech NUS, Inc.
USEPA	U.S. Environmental Protection Agency
VOCs	volatile organic compound

EXECUTIVE SUMMARY

The Southern Division, Naval Facilities Engineering Command has completed a Remedial Action Plan (RAP) for Site 20 at the Allegheny Pier, Naval Air Station Pensacola, Pensacola, Florida, in accordance with the requirements of Chapter 62-770, *Florida Administrative Code* (F.A.C.). This plan is being submitted to the Florida Department of Environmental Protection for approval.

The following tasks were performed during preparation of the RAP:

- Reviewed the Site Assessment Report and Site Assessment Report Addendum (NPWC, 1998; TtNUS, 2001).
- Evaluated remedial alternatives to address free product and groundwater contamination.
- Specified a sampling plan to track the remediation status of the site.

The remedial action goals of this RAP are to (1) identify a method to perform free-product recovery and (2) select a remedial action to reduce hydrocarbon and lead concentrations within the groundwater matrix. This RAP identifies a combination of vacuum extraction and absorbent socks as the selected alternative for free-product removal and groundwater extraction by pump and treat with discharge to the publicly owned treatment works as the selected alternative for remediation at Site 20. The remedial alternative was selected because it was determined to be the most effective method for the removal of free product and remediation of groundwater. If implemented, the free-product recovery system will require approximately 3 months to design and construct and 9 months to remove measurable free product. Twelve to 18 months will be required for groundwater recovery system design and construction. Active groundwater remediation will occur for approximately 1 year on a limited basis until free product is removed and than continue for an additional 5 years. Post-remedial action activities specified in Chapter 62-770 F.A.C. will require a minimum of 12 months of monitoring.

1.0 INTRODUCTION

1.1 PURPOSE AND SCOPE

This Remedial Action Plan (RAP) was prepared by Tetra Tech NUS, Inc. (TtNUS) for the United States Navy (Navy) Southern Division, Naval Facilities Engineering Command under Contract Task Order 0112, for the Comprehensive Long-term Environmental Action Navy (CLEAN), Contract Number N62467-94-D-0888.

In July 1998, a Site Assessment Report (SAR) for Site 20, Allegheny Pier (Pier 303), Naval Air Station (NAS), Pensacola, Florida was submitted by the Navy Public Works Center (NPWC) to the Florida Department of Environmental Protection (FDEP) for review, and a Site Assessment Report Addendum (SARA) (TtNUS, 2001) was submitted to FDEP on May 23, 2001. Following the approval of the SARA, the FDEP requested the preparation and submittal of a RAP to address free-product removal at Site 20.

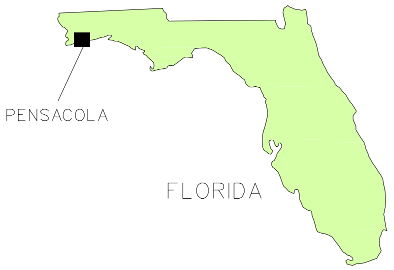
This RAP contains the identification, evaluation, and selection of the remedial action alternative to remove free product and to remediate groundwater in accordance with the requirements of Chapter 62-770 *Florida Administrative Code* (F.A.C). This RAP provides an evaluation of applicable alternatives that protect human health and the environment, reduce hydrocarbon constituent concentrations within soil and groundwater, and retard further migration of hydrocarbon constituents to downgradient areas. The RAP includes a design for the selected remedial alternative.

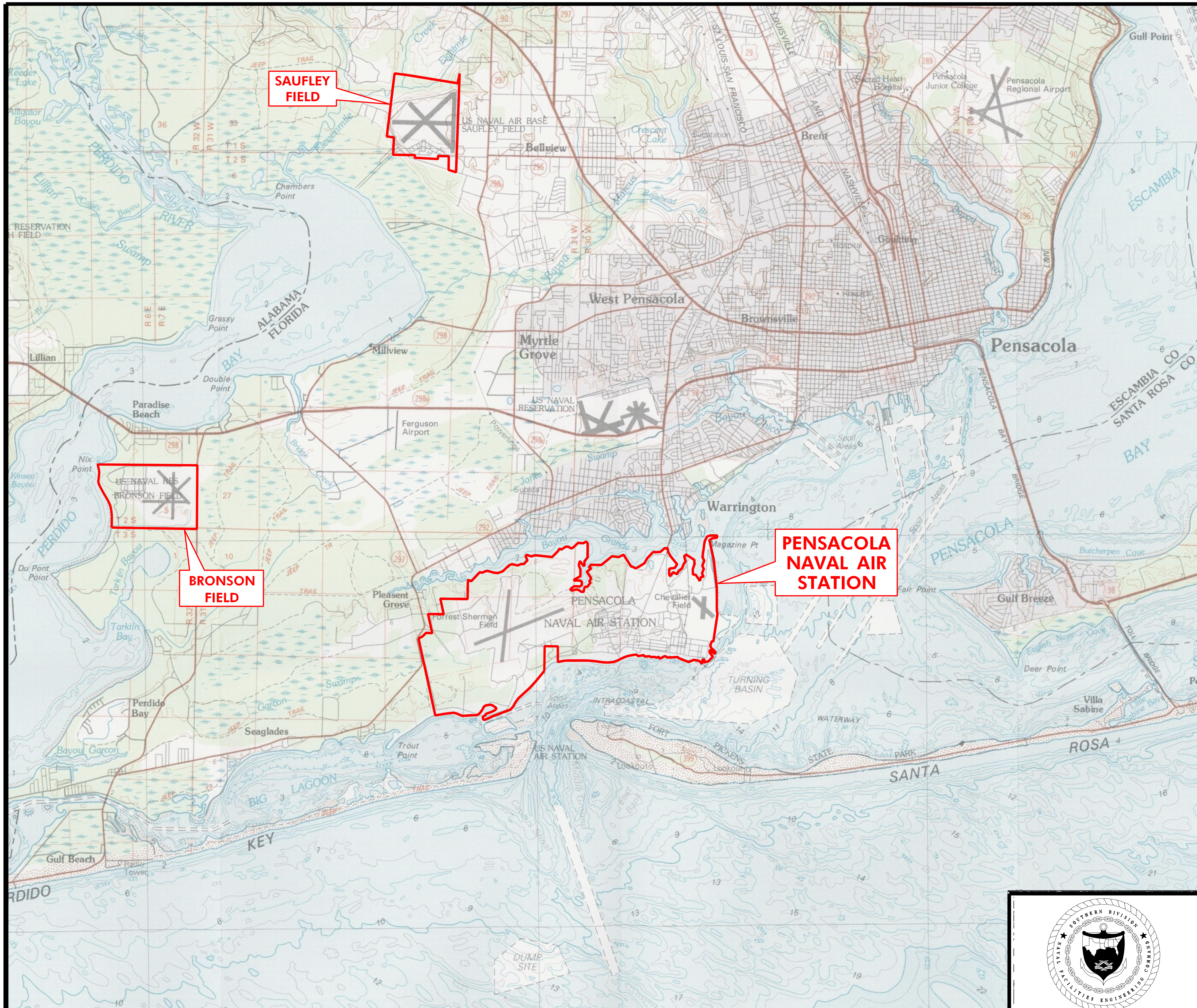
1.2 SITE DESCRIPTION

NAS Pensacola covers approximately 5,800 acres and is located on a peninsula bounded on the east and south by Pensacola Bay and Big Lagoon and on the north by Bayou Grande. Allegheny Pier (Pier 303) is located within the confines of NAS Pensacola in Section 1, Range 30W, and Township 3S. The site is located approximately ¼ mile south of Chevalier Field. Figures 1-1 and 1-2 illustrate the site location and site vicinity, respectively.

The pier area is situated along the Pensacola Bay shoreline and consists of an approximately 30-foot-wide concrete loading area immediately adjacent to the pier seawall, surrounded by a large asphalt parking lot. Previously there was a 1,300,000-gallon aboveground fuel storage tank (No. 354) with a concrete containment wall adjacent to and west of the pier. Tank No. 354 was removed on November 17, 1993, and not replaced. The site area extended approximately 1,000 feet north of the former storage tank location and interfaces with Buildings 707, 52, 18, and 2573. The site plan is shown on Figure 1-3.

SOURCE:
TAKEN FROM 1:100000 SCALE U.S.G.S. TOPOGRAPHIC QUADRANGLE PENSACOLA, FLORIDA-ALABAMA (1978 EDITION).





N

10000 0 10000
SCALE IN FEET

FIGURE 1-1

SITE LOCATION MAP
SITE NO. 20
REMEDIAL ACTION PLAN

NAS PENSACOLA
PENSACOLA, FLORIDA

CAD FILE NO./DATE: k:\dgn\navy\pensacola\ 0401L\ 0401L001.dgn/10-24-01

n11x17b.dgn

SOURCE:
TAKEN FROM U.S.G.S. TOPOGRAPHIC QUADRANGLE FORT BARRANCAS, FLORIDA (1970 EDITION - PHOTOREVISED 1987).

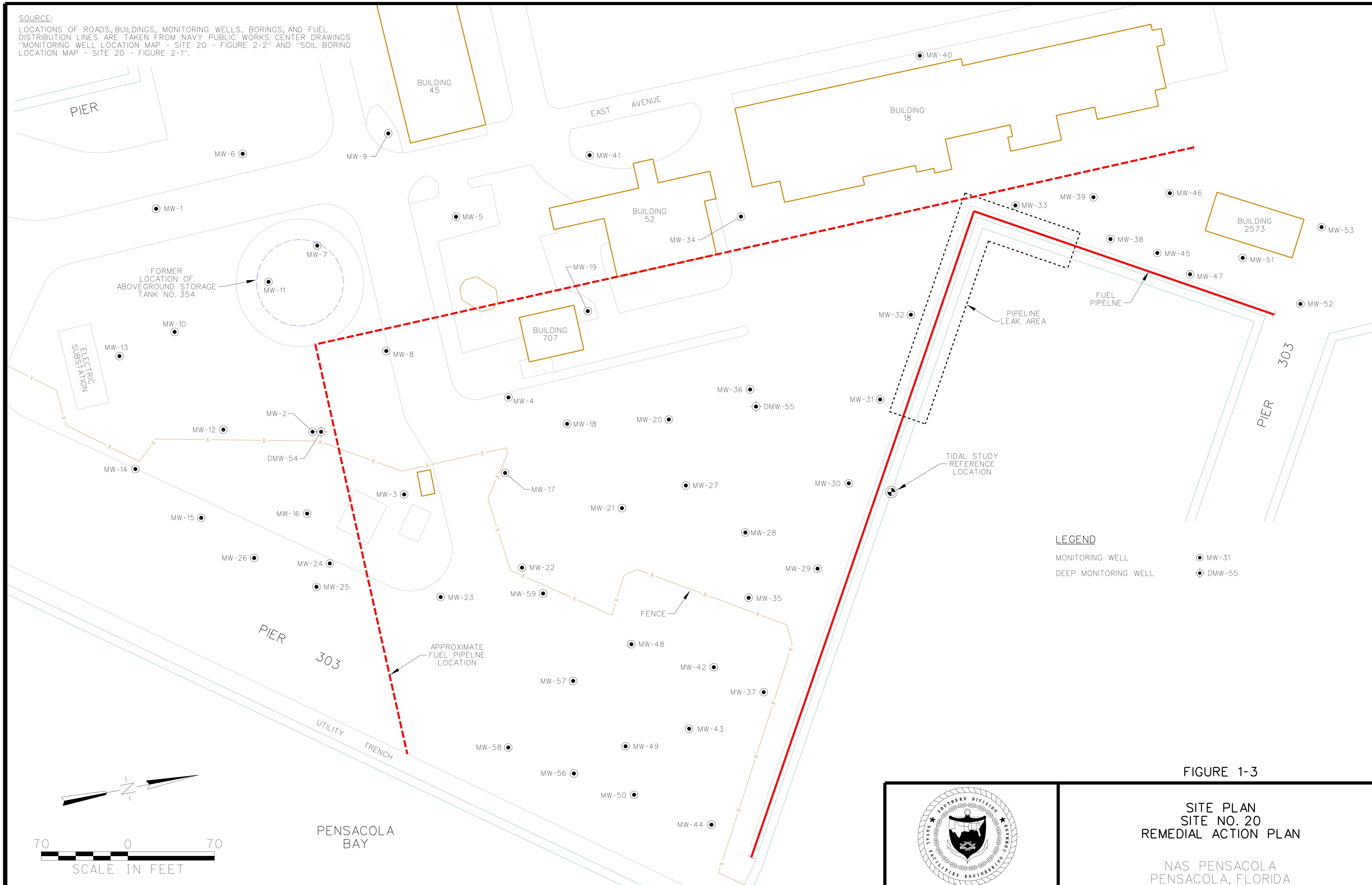
FIGURE 1-2

SITE VICINITY MAP
SITE NO. 20
REMEDIAL ACTION PLAN

NAS PENSACOLA
PENSACOLA, FLORIDA

CAD FILE NO./DATE: k:\dgn\navy\pensacola\ 0401L\ 0401L002.dgn/10-24-01

n11x17b.dgn


SOURCE:
LOCATIONS OF ROADS, BUILDINGS, MONITORING WELLS, BORINGS, AND FUEL DISTRIBUTION LINES ARE TAKEN FROM NAVY PUBLIC WORKS CENTER DRAWINGS "MONITORING WELL LOCATION MAP - SITE 20 - FIGURE 2-2" AND "SOIL BORING LOCATION MAP - SITE 20 - FIGURE 2-1".
PIER
BUILDING 45
EAST AVENUE
BUILDING 18
BUILDING 52
BUILDING 707
BUILDING 2573
FORMER LOCATION OF ABOVEGROUND STORAGE TANK NO. 354
ELECTRIC SUBSTATION
PIPELINE LEAK AREA
FUEL PIPELNE
TIDAL STUDY REFERENCE LOCATION
FENCE
APPROXIMATE FUEL PIPELNE LOCATION
PIER 303
PIER 303
UTILITY TRENCH
PENSACOLA BAY
LEGEND
MONITORING WELL MW-31
DEEP MONITORING WELL DMW-55
70 0 70
SCALE IN FEET
N
FIGURE 1-3
SITE PLAN
SITE NO. 20
REMEDIAL ACTION PLAN
NAS PENSACOLA
PENSACOLA, FLORIDA
SOUTHERN DIVISION NAVAL FACILITIES ENGINEERING COMMAND
CAD FILE NO./DATE: k:\dgn\navy\pensacola\ 0401L\ 0401L003.dgn/10-24-01
n11x17b.dgn

1.3 SITE HISTORY

The site is a former “berthing pier area” that has fueling capabilities. The former aboveground storage tank (No. 354) was used to contain Navy Special Fuel Oil, Distillate DFM, and JP-5 Jet Fuel since 1926 (NEESA, 1983). The tank may have been modified or replaced in the past. Pipelines extended from the fuel storage tank, presumably north toward Building 2573 to the berthing pier (structure No. 303) and possibly to other ship fueling areas.

The pipelines were inactive for several years. In 1981, a leak was discovered in the fuel pipeline leading to the berthing pier. Either the lines had broken during the years of usage or the abandoned line was penetrated while a contractor was driving piles. The soil in the area of the leak appeared soaked with fuel oil, reportedly Navy Special Fuel Oil or marine diesel fuels. An unknown volume of soil was removed and properly disposed of in 1981 (NEESA, 1983).

In November 1993, the presence of petroleum constituents at the wastewater treatment plant led to an investigation of the sanitary sewer lines. Oil/fuel was discovered in the lines leading from the berthing pier to the wastewater treatment plant. Possible contamination was thought to have occurred during construction modifications to the pier. The tank was removed in 1993, but the pipelines were not. No closure assessment was performed because the site was on the FDEP/Navy petroleum agreement list for further investigation.

1.4 REPORT ORGANIZATION

This report is organized into eight sections. Below is a list of the sections and a brief description of their purpose:

Section 1: Introduction. Presents the report’s purpose, scope, site information, and report organization.

Section 2: Site Assessment Reports Findings and Conclusions. Reviews the approved SARA and summarizes the SAR and SARA’s findings and conclusions.

Section 3: Remedial Action Objectives. Sets the free-product removal and groundwater cleanup objectives.

Section 4: Contaminant Distribution. Estimates the volume of free product at Site 20.

Section 5: Remedial Technologies. Presents the alternatives for remediation, determines the suitability to the site, develops budgetary costs for each, and selects preferred alternative.

Section 6: Remedial System Design. Presents all of the assumptions made and provides the detailed design of the preferred remedial alternative.

Section 7: Monitoring Plan and Project Closeout: Contains procedures for system implementation, routine O&M, and final reporting and monitoring after completion.

Section 8: References. Lists all references used.

2.0 SITE ASSESSMENT REPORTS FINDINGS AND CONCLUSIONS

In July 1998, a SAR for Site 20, Allegheny Pier, NAS, Pensacola was submitted by NAS Pensacola NPWC to the FDEP for review and a SARA (TtNUS, 2001) was completed and submitted to FDEP on May 23, 2001. The SAR and SARA were conducted to determine the extent of free product and soil and groundwater contamination at the site. The following is a summary of the findings of the SAR and SARA for Site 20.

2.1 LITHOLOGIC FINDINGS

The principal area of concern at the site is the surficial zone of the sand and gravel aquifer. Monitoring wells were installed in the surficial zone to a depth of 25.5 feet during the SAR investigation. The lithology at the site was found to be consistent and generally composed of (1) asphalt and road sub-base from 0-1 feet below land surface (bls); (2) light brown to grey, fine silty sand from 1 to 4 feet bls; (3) white, silty, fine sand from 4 to 6 feet bls; (4) reddish-white, fine to medium, silty sand from 6 to 7 feet bls; (5) tan, fine to medium, silty sand from 7 to 10 feet bls; (6) grey, fine to medium, silty sand from 10 to 18 feet bls; (7) tan, medium to coarse, silty sand from 18 to 25 feet bls. The groundwater table at the site was encountered between 6 and 7 feet bls. Lithological logs describing the soil encountered are located in the SAR and SARA for Site 20.

2.2 GROUNDWATER AND AQUIFER CHARACTERISTICS

The SAR indicated that the depth to groundwater ranged from approximately 4.5 to 10 feet bls and, although groundwater flow fluctuated, generally flows to the southeast toward the bay. In December 2000 the measured groundwater table at Site 20 appeared to be relatively flat with slight flow direction to the east and south. Depth to groundwater ranged from approximately 5 to 11 feet bls. Table 2-1 presents the groundwater elevations from December 2000. Figure 2-1 presents the groundwater elevation map from December 2000.

The SAR for Site 20 stated that because the hydrogeology at the site was found to be generally consistent with other sites at NAS Pensacola, slug test information from three other sites at NAS Pensacola could be averaged to provide the aquifer characteristics data for Site 20.

TABLE 2-1

GROUNDWATER AND FREE PRODUCT LEVEL DATA ON DECEMBER 6, 2000

SITE 20, ALLEGHENY PIER (PIER 303) NAS PENSACOLA, PENSACOLA, FLORIDA

Well Number	Top of Casing Elevation (1) (ft)	Depth to Product BTOC (ft)	Depth to Water BTOC (ft)	Free Product Thickness (ft)	Groundwater Elevation (1) (2) (ft)
MW-1	25.86	NA	6.7	NA	19.16
MW-2	28.51	9.29	9.63	0.34	19.19
MW-3	28.59	NA	9.42	NA	19.17
MW-4	28.48	NA	9.27	NA	19.21
MW-5	25.97	NA	6.69	NA	19.28
MW-6	25.11	NA	6.86	NA	18.25
MW-7	26.08	NA	6.82	NA	19.26
MW-8	27.93	8.70	9.25	0.55	19.18
MW-9	26.01	NA	6.70	NA	19.31
MW-10	26.88	NA	7.70	NA	19.18
MW-11	26.39	7.17	7.21	0.04	19.22
MW-12	28.11	8.92	9.06	0.14	19.18
MW-13	27.00	NA	7.85	NA	19.15
MW-14	27.87	NA	8.74	NA	19.13
MW-15	28.23	NA	9.07	NA	19.16
MW-16	28.53	NA	9.20	NA	19.33
MW-17	29.41	NA	10.21	NA	19.20
MW-18	29.38	NA	10.15	NA	19.23
MW-19	27.98	8.63	9.10	0.47	19.30
MW-20	29.42	NA	10.21	NA	19.21
MW-21	29.82	NA	10.66	NA	19.16
MW-22	29.62	NA	10.46	NA	19.16
MW-23	28.76	NA	9.60	NA	19.16
MW-24	28.47	NA	9.31	NA	19.16
MW-25	28.37	NA	9.21	NA	19.16
MW-26	27.97	NA	8.80	NA	19.17
MW-27	29.72	NA	10.53	NA	19.19
MW-28	29.38	NA	10.22	NA	19.16
MW-29	28.28	NA	9.13	NA	19.15
MW-30	28.63	9.30	10.43	1.13	19.22
MW-31	28.34	9.00	9.97	0.97	19.24
MW-32	28.02	8.64	10.04	1.40	19.24
MW-33	27.24	8.09	8.17	0.08	19.14
MW-34	26.00	6.65	6.70	0.05	19.35
MW-35	28.72	NA	9.59	NA	19.13
MW-36	28.75	9.35	10.77	1.42	19.26
MW-37	28.00	NA	8.90	NA	19.10

TABLE 2-1

GROUNDWATER AND FREE PRODUCT LEVEL DATA ON DECEMBER 6, 2000

SITE 20, ALLEGHENY PIER (PIER 303) NAS PENSACOLA, PENSACOLA, FLORIDA

Well Number	Top of Casing Elevation [(1)] (ft)	Depth to Product BTOC (ft)	Depth to Water BTOC (ft)	Free Product Thickness (ft)	Groundwater Elevation [(1) (2)] (ft)
MW-38	27.70	NA	8.49	NA	19.21
MW-39	26.46	NA	7.10	NA	19.36
MW-40	24.38	NA	4.87	NA	19.51
MW-41	25.36	NL	NL	NA	NA
MW-42	28.71	NA	9.59	NA	19.12
MW-43	28.50	NA	9.40	NA	19.10
MW-44	28.14	NA	9.05	NA	19.09
MW-45	26.51	NA	7.58	NA	18.93
MW-46	26.94	NA	7.08	NA	19.86
MW-47	27.55	NA	8.33	NA	19.22
MW-48	29.28	NA	10.15	NA	19.13
MW-49	28.26	NA	9.15	NA	19.11
MW-50	27.88	NA	8.75	NA	19.13
MW-51	27.69	NA	8.41	NA	19.28
MW-52	28.13	NM	NM	NA	NA
MW-53	27.47	NA	8.12	NA	19.35
DMW-54	28.53	NA	9.32	NA	19.21
DMW-55	28.93	NA	9.67	NA	19.26
MW-56	28.21	NA	9.10	NA	19.11
MW-57	28.71	NA	9.57	NA	19.14
MW-58	28.22	NA	9.07	NA	19.15
MW-59	29.33	NA	10.17	NA	19.16

Notes:
(1) Elevations based upon arbitrary elevation of 30 feet above MSL assigned to the northeast corner of an existing concrete light pole.
(2) A specific gravity of 0.9 (for Bunker "C" oil) used in water level calculations to correct for free product : depth to water - (free product thickness*0.90) = corrected depth to water
BTOC - Below Top of Casing
MSL - Mean Sea Level Datum
NA - not applicable
NL - not located
NM - not measured due to probe refusal at 3.45 feet.

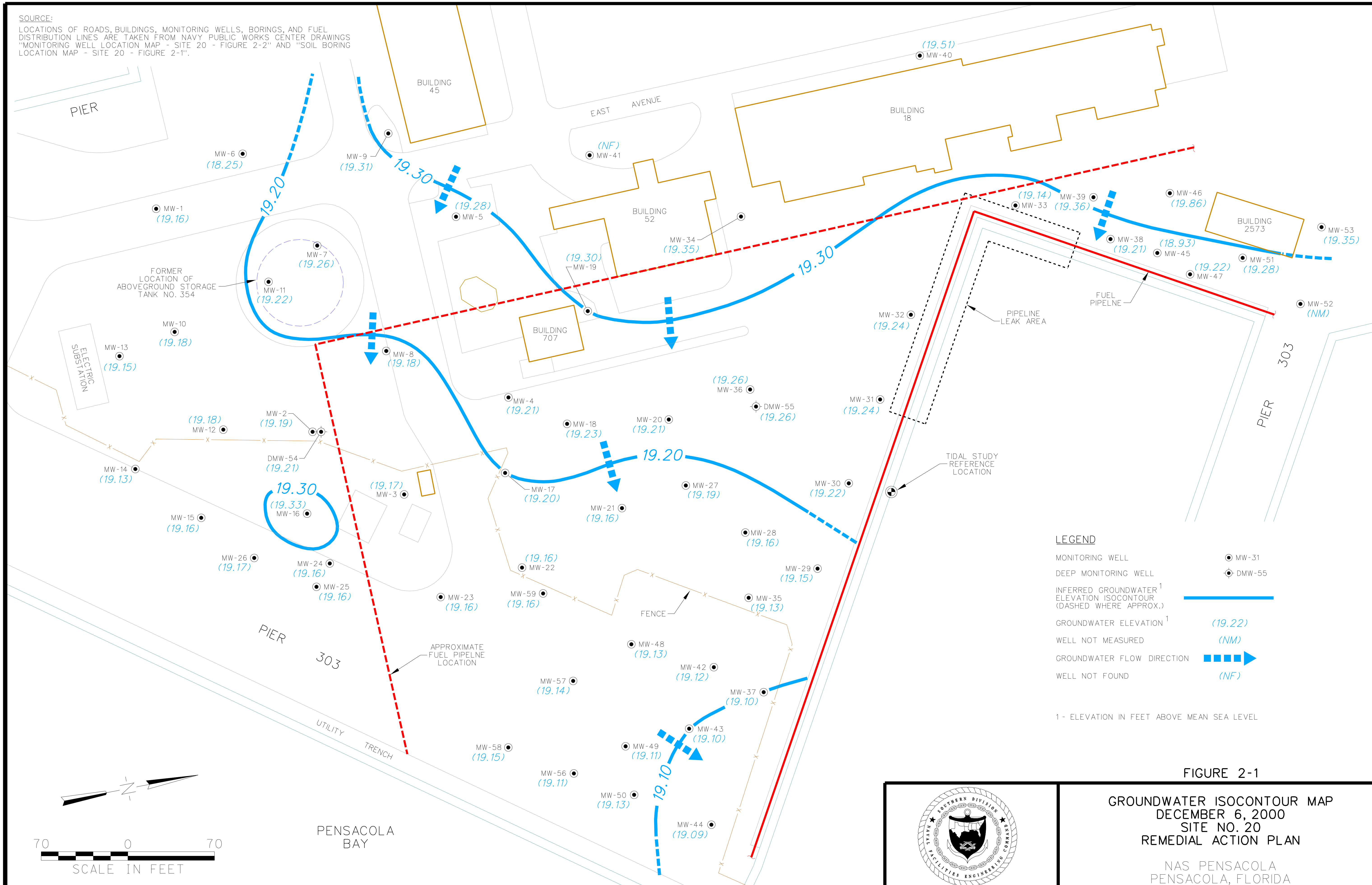


FIGURE 2-1

GROUNDWATER ISOCONTOUR MAP
DECEMBER 6, 2000
SITE NO. 20
REMEDIAL ACTION PLAN

NAS PENSACOLA
PENSACOLA, FLORIDA

CAD FILE NO./DATE: k:\dgn\navy\pensacola\ 0401L\ 0401L004.dgn/10-25-01

The following aquifer parameters were estimated in the SAR (NPWC, 1998).

Hydraulic conductivity	K =	48.3 feet per day
Flow velocity	V =	0.037 feet per day
Effective porosity	n_e =	0.25 (unitless)

2.3 SOIL CONTAMINATION ASSESSMENT

The vertical and horizontal extent of petroleum-impacted soil in the vadose zone was assessed through soil vapor analysis performed during the field investigations described in the SAR and SARA for Site 20 (NPWC, 1998; TtNUS, 2001). The SAR soil assessment at Site 20 consisted of screening the soil for petroleum vapors with an organic vapor analyzer (OVA) during the installation of soil borings and monitoring wells. Eighty-five soil borings (SB-1 through SB-85) were installed at the site to a depth of 6 to 7 feet bls in June through October 1996. Fifty-three additional soil borings (BH-1 through BH-53) were installed from September 1996 through February 1997 to a depth of 7 feet bls. Soil samples were collected at each borehole at depths of 1, 4, and 5-7 feet bls intervals and analyzed for volatile organic vapors using an OVA with a flame ionization detector (FID). Soil samples were also collected during the installation of monitoring wells MW-1 through MW-59 at approximately 1-, 4-, and 6-foot intervals bls and analyzed with an OVA for volatile organic compounds (VOCs). Soil analytical results from the SAR are summarized on Table 2-2. Soil boring locations are indicated on Figure 2-2. Areas of excessively contaminated soil are shown on Figures 2-3a through 2-3c.

During the SAR field investigation, the groundwater table was generally encountered at 5 to 8 feet bls. Results of the SAR field investigation stated that the VOC readings taken from three areas of the site (the tank area, Building 18, and monitoring wells) indicated that the areal extent of soil contamination was widespread and extensive.

On August 3, 4, and 8, 2000, 18 soil borings (SB-1 through SB-4, SB-6 through SB-17, SB-19, and SB-20) were completed to depths ranging from 5 to 9 feet bls using Direct Push Technology (DPT). The soil borings were installed to further characterize the site contamination and the extent of free product. During soil boring operations an on-site geologist recorded lithologic descriptions of the soil and identified the presence of free product. These soil boring locations are shown on Figure 2-4.

A single soil sample was collected from each of the 18 soil borings except SB-10 from which a duplicate sample was collected.

TABLE 2-2

SUMMARY OF ANALYTES DETECTED IN SOIL

SITE 20, ALLEGHENY PIER (PIER 303)
NAS PENSACOLA, PENSACOLA, FLORIDA

Sample No. Sample Location Collect Date Sample Depth (bls)	Florida Cleanup Levels	NASP20SB-1 SB-1 8/3/2000 6 feet	NASP20SB-2 SB-2 8/3/2000 6 feet	NASP20SB-3 SB-3 8/4/2000 6 feet	NASP20SB-4 SB-4 8/4/2000 6 feet	NASP20SB-6 SB-6 8/4/2000 6-7 feet
	DE1[1]/DE2[2]/LE[3] (mg/kg)					
Volatile[4] (mg/kg)						
Ethylbenzene	1100/8400/0.6	--	0.252^{J}	0.526	--	--
Methylene Chloride	16/23/0.02	--	--	--	--	--
Trichloroethene	6/8.5/0.03	--	--	--	--	--
Total Xylenes	5900/40000/0.2	--	--	**0.736^{J}**	--	--
Polycyclic Aromatic Hydrocarbons[5] (mg/kg)						
1-Methylnaphthalene	68/470/2.2	**3.69**	**18.2**	**14.2**	**13**	--
2-Methylnaphthalene	80/560/6.1	3.91	**24.4**	**17.4**	**17**	--
Benzo(a)anthracene	1.4/5.0/3.2	0.685	--	--	--	--
Benzo(a)pyrene	0.1/0.5/8	0.397	--	--	--	--
Benzo(b)fluoranthene	1.4/4.8/10	0.486	--	--	--	--
Benzo(g,h,i)perylene	2300/41000/32000	0.27^{J}	--	--	--	--
Benzo(k)fluoranthene	15/52/25	0.269^{J}	--	--	--	--
Chrysene	140/450/77	--	--	--	--	--
Fluorene	2200/28000/160	--	3.95^{J}	2.82^{J}	2.73^{J}	--
Fluoranthene	2900/48000/1200	1.92	--	--	--	--
Indeno(1,2,3-cd)pyrene	1.5/5.3/28	0.445	--	--	--	--
Naphthalene	40/270/1.7	--	**5.61^{J}**	**3.37^{J}**	--	--
Phenanthrene	2000/30000/250	2.34	12.5	4.91^{J}	4.24^{J}	--
Pyrene	2200/37000/880	1.58^{J}	--	--	--	--
Total Recoverable Petroleum Hydrocarbons[6] (mg/kg)	340/2500/340	**10200**	**8520**	**6360**	**4790**	8.44^{J}

TABLE 2-2

SUMMARY OF ANALYTES DETECTED IN SOIL

SITE 20, ALLEGHENY PIER (PIER 303)
NAS PENSACOLA, PENSACOLA, FLORIDA

Sample No. Sample Location Collect Date Sample Depth (bls)	Florida Cleanup Levels	NASP20SB-7 SB-7 8/4/2000 9 feet	NASP20SB-8 SB-8 8/4/2000 8 feet	NASP20SB-9 SB-9 8/4/2000 9 feet	NASP20SB-10 SB-10 8/4/2000 9 feet	NASP20DUP-1 SB-10 Duplicate 8/4/2000 6-7 feet
	DE1[1]/DE2[2]/LE[3] (mg/kg)					
Volatile[4] (mg/kg)						
Ethylbenzene	1100/8400/0.6	--	--	--	--	--
Methylene Chloride	16/23/0.02	--	--	--	--	--
Trichloroethene	6/8.5/0.03	--	--	--	--	--
Total Xylenes	5900/40000/0.2	--	--	--	--	--
Polycyclic Aromatic Hydrocarbons[5] (mg/kg)						
1-Methylnaphthalene	68/470/2.2	0.24^{J}	0.783	--	0.955^{J}	1.64^{J}
2-Methylnaphthalene	80/560/6.1	0.259^{J}	1	--	1.13	1.76
Benzo(a)anthracene	1.4/5.0/3.2	--	--	--	--	--
Benzo(a)pyrene	0.1/0.5/8	--	--	--	--	--
Benzo(b)fluoranthene	1.4/4.8/10	--	--	--	--	--
Benzo(g,h,i)perylene	2300/41000/32000	--	--	--	--	--
Benzo(k)fluoranthene	15/52/25	--	--	--	--	--
Chrysene	140/450/77	--	--	--	--	--
Fluorene	2200/28000/160	0.11^{J}	--	--	--	--
Fluoranthene	2900/48000/1200	--	--	--	--	--
Indeno(1,2,3-cd)pyrene	1.5/5.3/28	--	--	--	--	--
Naphthalene	40/270/1.7	--	--	--	--	--
Phenanthrene	2000/30000/250	0.28^{J}	0.386^{J}	--	0.385^{J}	0.545^{J}
Pyrene	2200/37000/880	--	--	--	--	--
Total Recoverable Petroleum Hydrocarbons[6] (mg/kg)	340/2500/340	100	**5140**	8.86	**2740^{J}**	**1240^{J}**

TABLE 2-2

SUMMARY OF ANALYTES DETECTED IN SOIL

SITE 20, ALLEGHENY PIER (PIER 303)
NAS PENSACOLA, PENSACOLA, FLORIDA

Sample No. Sample Location Collect Date Sample Depth (bls)	Florida Cleanup Levels	NASP20SB-11 SB-11 8/4/2000 8 feet	NASP20SB-12 SB-12 8/7/2000 8 feet	NASP20SB-13 SB-13 8/7/2000 8 feet	NASP20SB-14 SB-14 8/7/2000 8 feet	NASP20SB-15 SB-15 8/7/2000 8 feet
	DE1[1]/DE2[2]/LE[3] (mg/kg)					
Volatile[4] (mg/kg)						
Ethylbenzene	1100/8400/0.6	--	--	--	--	--
Methylene Chloride	16/23/0.02	--	--	--	0.0121	--
Trichloroethene	6/8.5/0.03	--	--	--	--	--
Total Xylenes	5900/40000/0.2	--	--	--	--	--
Polycyclic Aromatic Hydrocarbons[5] (mg/kg)						
1-Methylnaphthalene	68/470/2.2	**12.1**	**24.2**	--	--	1.55
2-Methylnaphthalene	80/560/6.1	**17.2**	**32.6**	--	--	1.77
Benzo(a)anthracene	1.4/5.0/3.2	--	--	--	--	0.576
Benzo(a)pyrene	0.1/0.5/8	--	--	--	--	**1.04**
Benzo(b)fluoranthene	1.4/4.8/10	--	--	--	--	0.763
Benzo(g,h,i)perylene	2300/41000/32000	--	--	--	--	0.594
Benzo(k)fluoranthene	15/52/25	--	--	--	--	0.434
Chrysene	140/450/77	--	--	--	--	0.555[J]
Fluorene	2200/28000/160	2.96[J]	3.4[J]	--	--	--
Fluoranthene	2900/48000/1200	--	--	--	--	0.784[J]
Indeno(1,2,3-cd)pyrene	1.5/5.3/28	--	--	--	--	0.819
Naphthalene	40/270/1.7	--	--	--	--	--
Phenanthrene	2000/30000/250	6.64[J]	6.93[J]	--	--	--
Pyrene	2200/37000/880	--	--	--	--	0.66[J]
Total Recoverable Petroleum Hydrocarbons[6] (mg/kg)	340/2500/340	**5040**	**12400**	--	--	**1100**

TABLE 2-2

SUMMARY OF ANALYTES DETECTED IN SOIL

SITE 20, ALLEGHENY PIER (PIER 303)
NAS PENSACOLA, PENSACOLA, FLORIDA

PAGE 4 OF 4

Sample No. Sample Location Collect Date Sample Depth (bls)	Florida Cleanup Levels	NASP20SB-16 SB-16 8/7/2000 7 feet	NASP20SB-17 SB-17 8/8/2000 8-9 feet	NASP20SB-19 SB-19 8/8/2000 5-6.5 feet	NASP20SB-20 SB-20 8/8/2000 6-7 feet
	DE1[1]/DE2[2]/LE[3] (mg/kg)				
Volatile[4] (mg/kg)					
Ethylbenzene	1100/8400/0.6	--	--	--	--
Methylene Chloride	16/23/0.02	**1.18**	--	**0.736**	--
Trichloroethene	6/8.5/0.03	**0.179[J]**	--	--	--
Total Xylenes	5900/40000/0.2	--	--	--	--
Polycyclic Aromatic Hydrocarbons[5] (mg/kg)					
1-Methylnaphthalene	68/470/2.2	**14**	**4.63**	**19.9**	**48.8**
2-Methylnaphthalene	80/560/6.1	**18.7**	4.48	**28.6**	**71.8**
Benzo(a)anthracene	1.4/5.0/3.2	--	1.14	--	--
Benzo(a)pyrene	0.1/0.5/8	--	**0.898**	--	--
Benzo(b)fluoranthene	1.4/4.8/10	--	1.03	--	--
Benzo(g,h,i)perylene	2300/41000/32000	--	0.395[J]	--	--
Benzo(k)fluoranthene	15/52/25	--	0.42[J]	--	--
Chrysene	140/450/77	--	1.28[J]	--	--
Fluorene	2200/28000/160	--	--	--	--
Fluoranthene	2900/48000/1200	--	3.27[J]	--	--
Indeno(1,2,3-cd)pyrene	1.5/5.3/28	--	0.44[J]	--	--
Naphthalene	40/270/1.7	**2.79[J]**	--	--	**6.56[J]**
Phenanthrene	2000/30000/250	--	1.82[J]	--	--
Pyrene	2200/37000/880	--	2.78[J]	--	--
Total Recoverable Petroleum Hydrocarbons[6] (mg/kg)	340/2500/340	**3580**	**8120**	**4100**	**7720**

[1] DE1 = Direct Exposure limit for residential area from Chapter 62-777, F.A.C.
[2] DE2 = Direct Exposure limit for industrial area from Chapter 62-777, F.A.C.
[3] LE = Leachability for groundwater limit from Chapter 62-777, F.A.C.
[4] SW-846 8260B
[5] SW-846 8310
[6] FDEP FL-PRO
[J] Indicates the presence of a chemical at an estimated concentration.
-- indicates analyte not detected.
Bold indicates an exceedance of regulatory limits.

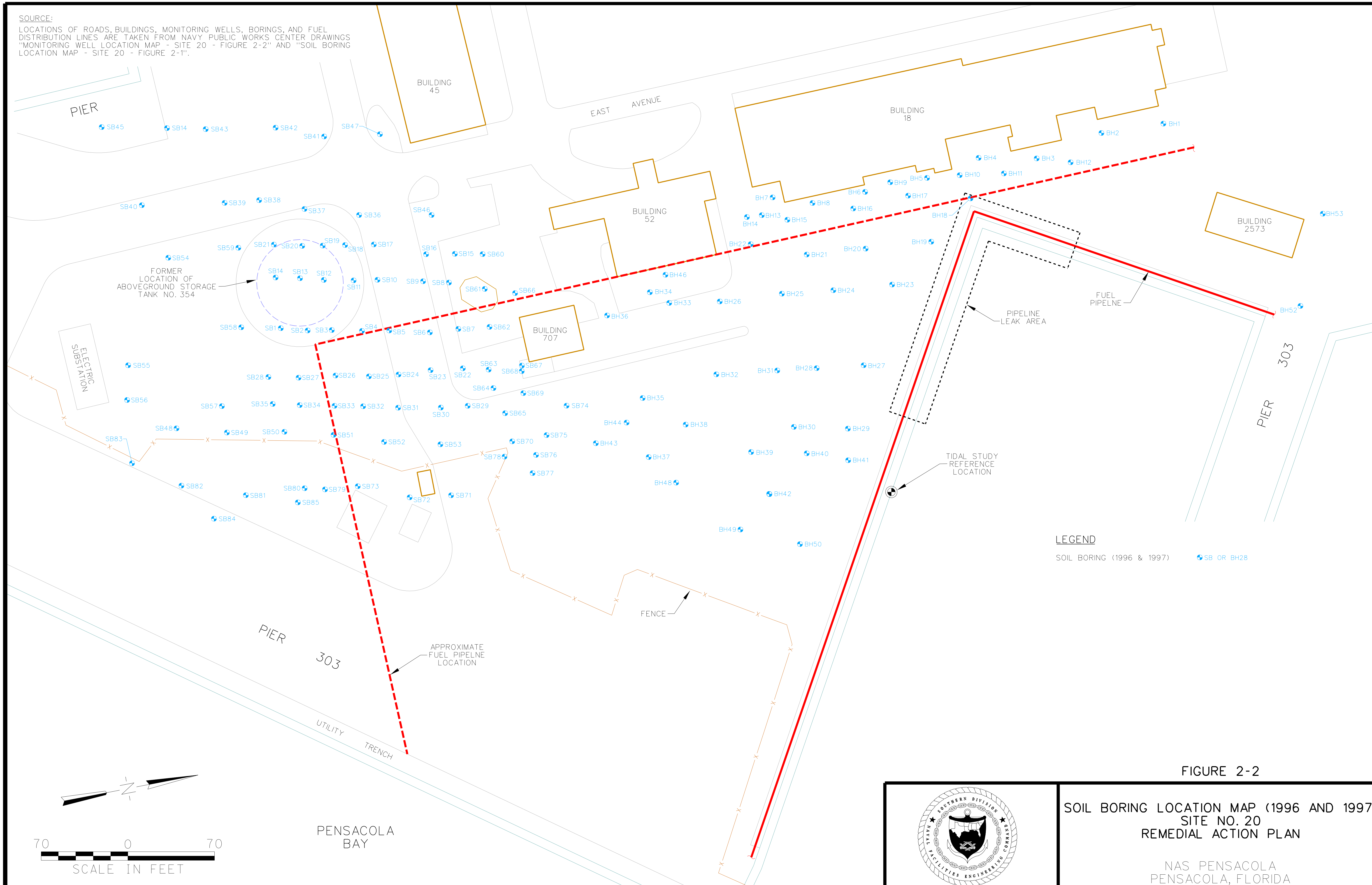


FIGURE 2-2

SOIL BORING LOCATION MAP (1996 AND 1997)
SITE NO. 20
REMEDIAL ACTION PLAN

NAS PENSACOLA
PENSACOLA, FLORIDA

CAD FILE NO./DATE: k:\dgn\navy\pensacola\ 0401I\ 0401L005.dgn/10-25-01

n11x17b.dgn

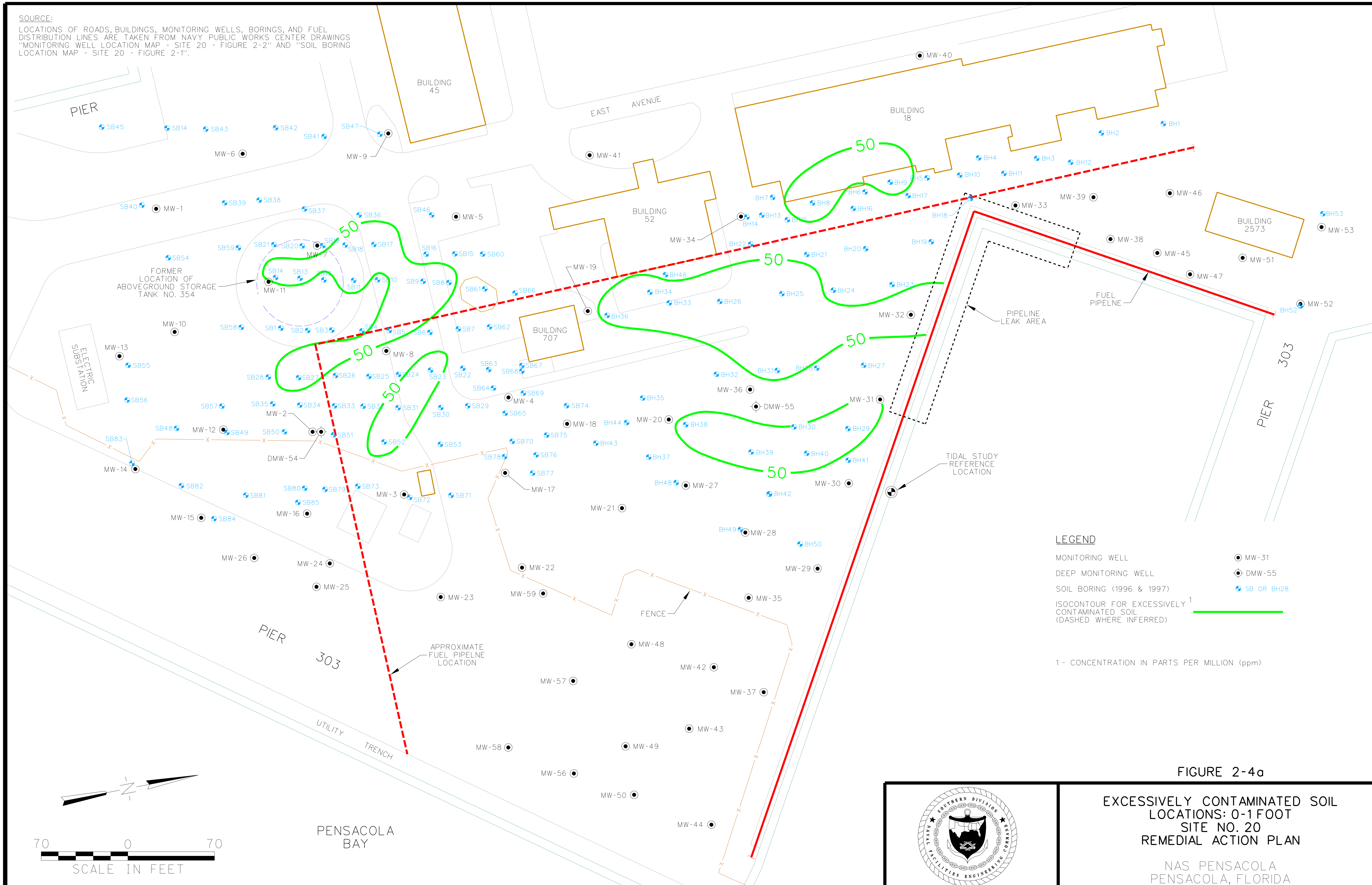


FIGURE 2-4a

EXCESSIVELY CONTAMINATED SOIL LOCATIONS: 0-1 FOOT
SITE NO. 20
REMEDIAL ACTION PLAN

NAS PENSACOLA
PENSACOLA, FLORIDA

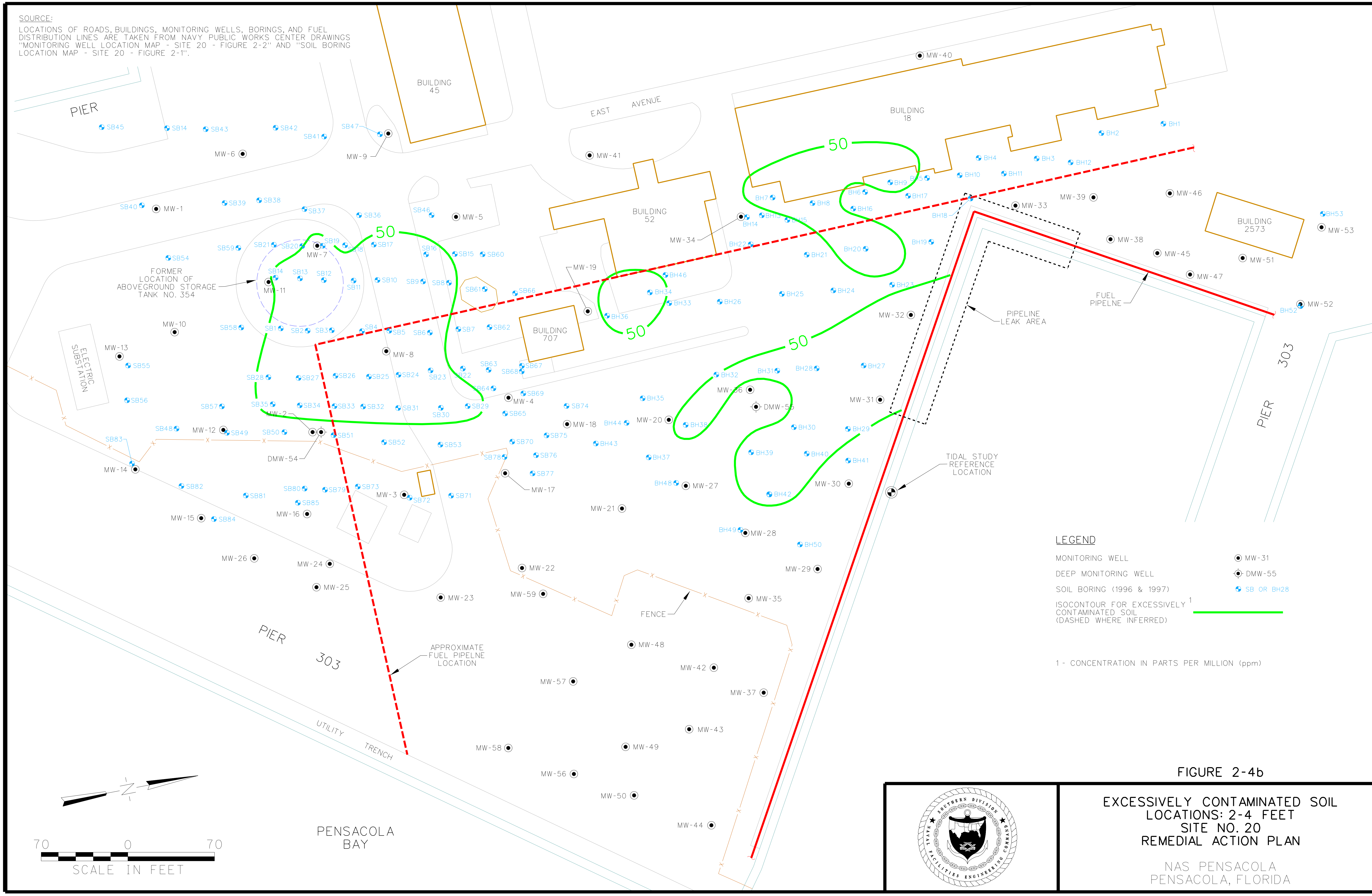


FIGURE 2-4b

EXCESSIVELY CONTAMINATED SOIL LOCATIONS: 2-4 FEET
SITE NO. 20
REMEDIAL ACTION PLAN

NAS PENSACOLA
PENSACOLA, FLORIDA

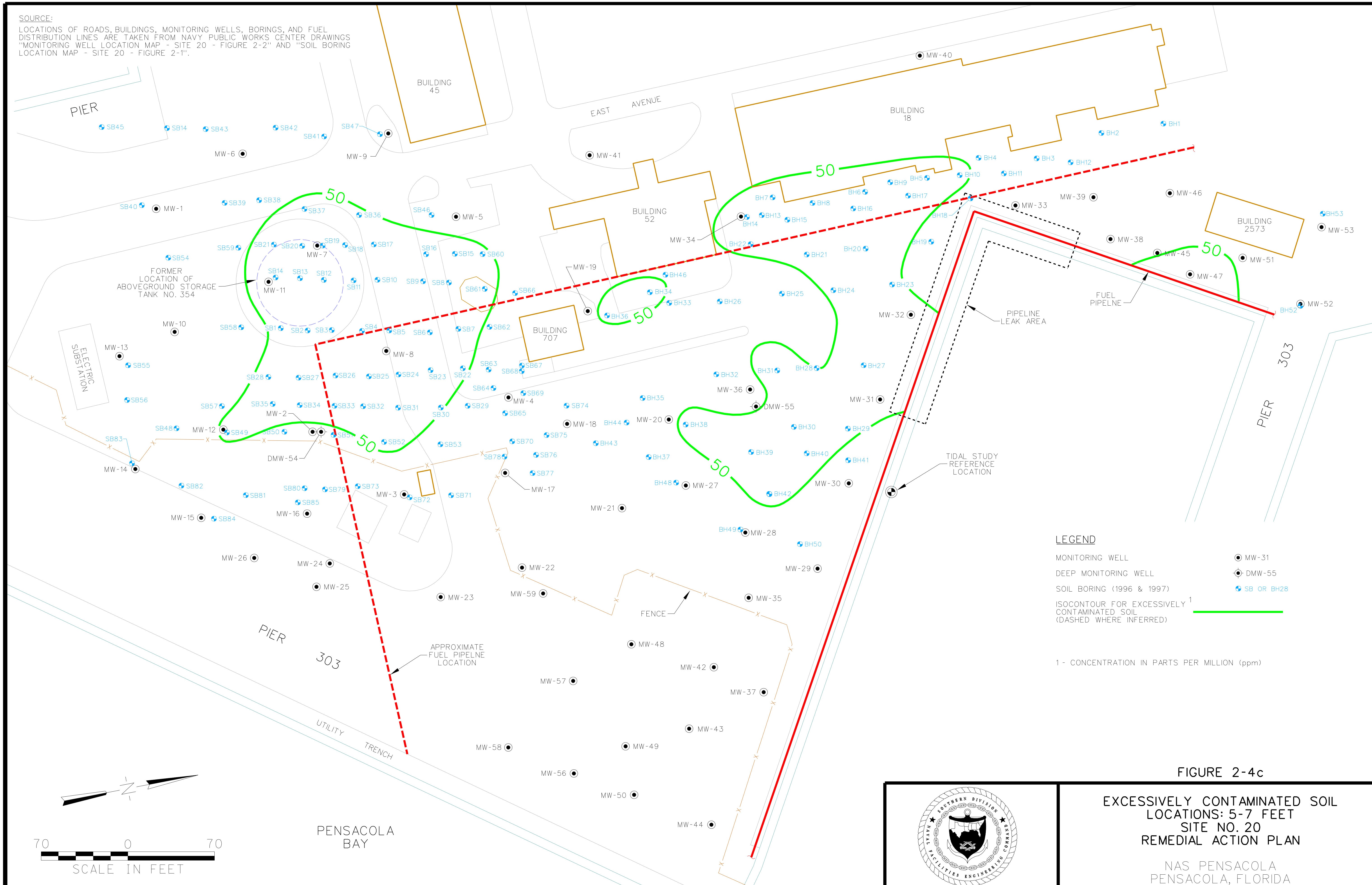


FIGURE 2-4c

EXCESSIVELY CONTAMINATED SOIL LOCATIONS: 5-7 FEET
SITE NO. 20
REMEDIAL ACTION PLAN

NAS PENSACOLA
PENSACOLA, FLORIDA

CAD FILE NO./DATE: k:\dgn\navy\pensacola\ 0401L\ 0401L009.dgn/10-25-01

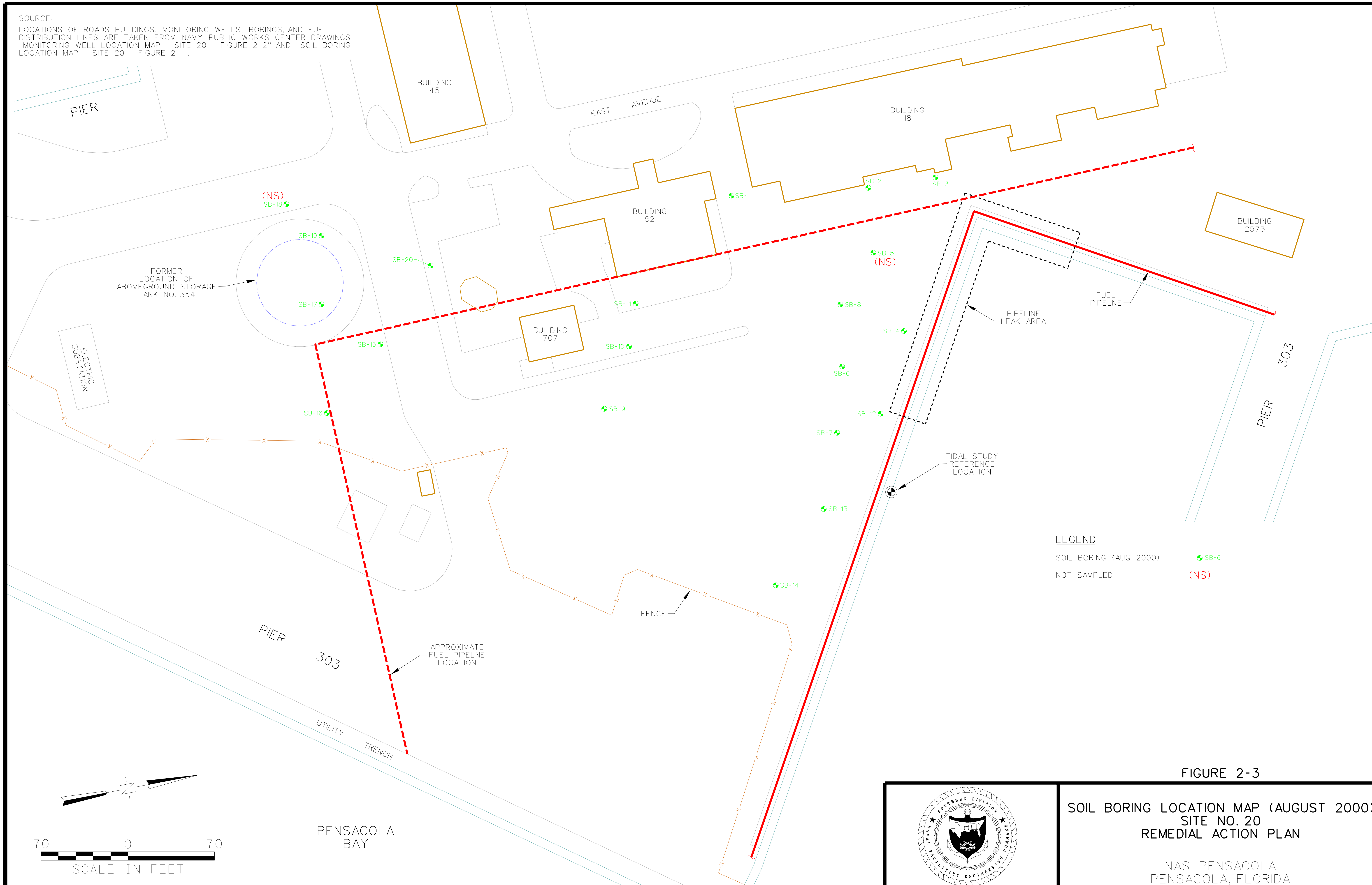


FIGURE 2-3

SOIL BORING LOCATION MAP (AUGUST 2000)
SITE NO. 20
REMEDIAL ACTION PLAN

NAS PENSACOLA
PENSACOLA, FLORIDA

CAD FILE NO./DATE: k:\dgn\navy\pensacola\ 0401L\ 0401L006.dgn/10-25-01

n11x17b.dgn

The soil samples were analyzed for compounds specified in the gasoline and kerosene analytical groups. Soil sampling field forms and soil boring log sheets are included in the SARA. The analytical results for the soil samples are summarized in Table 2-2.

Four VOCs (ethylbenzene, methylene chloride, trichloroethene, and total xylenes), were detected in the soil samples. Three of the VOCs [methylene chloride (soil borings SB-16, 1.18 mg/kg and SB-19, 0.736 mg/kg), trichloroethane (soil boring SB-16, 0.179 mg/kg estimated), and total xylenes (soil boring SB-3, 0.736 mg/kg estimated)] were detected at concentrations exceeding leachability limits for groundwater of 0.02 mg/kg, 0.03 mg/kg, and 0.2 mg/kg, respectively, from Chapter 62-777, F.A.C.

Fourteen polycyclic aromatic hydrocarbons (PAHs) were detected in the soil samples collected from Site 20. Three of the PAHs (1-methylnaphthalene, 2-methylnaphthalene, and naphthalene) were detected in several soil samples at concentrations exceeding the leachability for groundwater limits of 2.2 mg/kg, 6.1 mg/kg, and 1.7 mg/kg, respectively, from Chapter 62-777, F.A.C. Table 2-2 summarizes these findings.

Benzo(a)pyrene was detected in soil boring samples SB-15 (1.04 mg/kg) and SB-17 (0.898 mg/kg) at concentrations exceeding the direct exposure limits for both residential and industrial areas, 0.1 mg/kg and 0.5 mg/kg, respectively, from Chapter 62-777, F.A.C. However, it should be noted that, although direct exposure and leachability limits were exceeded, actual exposure and leachability are limited because the majority of the site is asphalt or concrete covered.

The soil samples were also analyzed for total recoverable petroleum hydrocarbons (TRPH). Concentrations of TRPH were detected in soil samples from 16 of the 18 (all but SB-13 and SB-14) soil borings. Thirteen of the 16 (all but SB-6, SB-7, and SB-9) detected TRPH concentrations exceeded both the direct residential exposure limit (340 mg/kg) and the leachability limit for groundwater (340 mg/kg) from Chapter 62-777, F.A.C. Twelve of the 13 (all but SB-15) also exceeded the direct industrial exposure limit (2,500 mg/kg).

A soil vapor table summarizing samples exceeding concentrations of 50 ppm is included in the SAR. Table 2-2 summarizes the analytes detected in soil samples from the SARA and the soil boring locations are shown on Figure 2-3. The analytical results indicate the presence of petroleum-impacted soil that exceed the FDEP target levels.

2.3.1 Identification and Selection of Soil COPCs

The first step in selecting soil chemicals of concern (COCs) was adjusting the soil cleanup target levels (SCTLs) for direct contact to account for the presence of multiple carcinogens or noncarcinogens that affect the same target organ/system in the list of chemicals of potential concern (COPCs). Six chemicals of interest (COIs) in soil were detected at maximum concentrations that exceeded the SCTL. Table 2-3 presents the initial screening process; lists all chemicals detected in soil, their maximum concentration, the State of Florida SCTL for industrial setting; and identifies the COPCs. COIs whose maximum concentration did not exceed the minimum SCTL were eliminated from further evaluation as COPCs.

As shown in Table 2-4, multiple carcinogens or noncarcinogens affecting the same target organ/system were adjusted by dividing the SCTL by the number of carcinogens or noncarcinogens that affect the same target organ or system to account for additive effects.

2.4 GROUNDWATER CONTAMINATION ASSESSMENT

Fifty-nine groundwater monitoring wells were installed during the SAR investigation (NPWC, 1998). Groundwater samples were collected from monitoring wells in 1996 and 1997 in support of the SAR. The groundwater samples were analyzed for VOCs, PAHs, TRPHs, ethylene dibromide (EDB), and lead using U.S. Environmental Protection Agency (USEPA) methods 8260, 8270A, FLPRO, 504, and 7421, respectively. A summary of analytes detected in groundwater is presented in Table 2-3.

Free product was discovered in monitoring wells MW-2, MW-8, MW-11, MW-12, MW-19, MW-29 through MW-34, MW-36, and MW-47. These monitoring wells were not sampled with the exception of monitoring wells MW-29 and MW-30, which were sampled for lead using the quiescent sampling method in September 1997.

The laboratory analysis of groundwater samples indicated one exceedance of benzene in DMW-55 at a concentration of 2 ppb, which is above the FDEP groundwater cleanup target level (GCTL) of 1 ppb. Vinyl chloride was detected in wells MW-7, MW-27, and MW-28 at concentrations of 37 ppb, 1 ppb, and 2 ppb, respectively, which are equal to or exceed the FDEP GCTL of 1 ppb. The FDEP GCTL of 20 ppb for total xylenes was exceeded in monitoring well DMW-54 at a concentration of 29 ppb. Other VOC parameters that were detected but did not exceed their respective FDEP GCTLs included trans-1,2-dichloroethene, toluene, trichloroethene, and methyl-tert-butyl-ether.

TABLE 2-3

SELECTION OF SOIL COCs

SITE 20, ALLEGHENY PIER (PIER 303)
NAS PENSACOLA, PENSACOLA, FLORIDA

COI [1]	Max Conc. (mg/kg)	SCTL Industrial (mg/kg) [2]	Adj. SCTL Industrial (mg/kg) [3]	SCTL Leach I (mg/kg) [4]	Exceeds Adj. Direct Contact	Initial Criteria (mg/kg) [5]	Target System/Organ
Volatile Organics							
Ethylbenzene	0.526	8,400	700	0.6	NO	0.60	Developmental - Kidney - Liver
Methylene Chloride	0.736	23	3	0.02	NO	0.02	Carcinogen -Liver
Trichloroethene	0.179	9	1	0.03	NO	0.03	Carcinogen
Xylenes, Total	0.736	40,000	3,333	0.2	NO	0.20	Body Weight -Mortality -Neurological
Semivolatile Organics							
1-Methylnaphthalene	48.8	470	39	2.2	YES	2.20	Body Weight -Nasal
2-Methylnaphthalene	71.8	560	47	6.1	YES	6.10	Body Weight -Nasal
Benzo(a)anthracene	1.14	5	1	3.2	YES	0.63	Carcinogen
Benzo(a)pyrene	1.04	1	0.06	8	YES	0.06	Carcinogen
Benzo(b)fluoranthene	1.03	4.8	1	10	YES	0.60	Carcinogen
Benzo(g,h,i)perylene	0.594	41,000	3,417	32000	NO	3,417	Neurological
Benzo(k)fluoranthene	0.434	52	7	25	NO	6.50	Carcinogen
Chrysene	1.28	450	56	77	NO	56.25	Carcinogen
Fluorene	3.95	28,000	2,333	160	NO	160	Blood
Fluoranthene	3.27	48,000	4,000	1200	NO	1,200	Blood -Kidney -Liver
Indeno(1,2,3-cd)pyrene	0.445	5.3	1	28	NO	0.66	Carcinogen
Naphthalene	6.56	270	23	1.7	NO	1.70	Body Weight -Nasal
Phenanthrene	12.5	30,000	2,500	250	NO	250	Kidney
Pyrene	2.78	37,000	3,083	880	NO	880	Kidney
TPH	12,400	2,500	208	340	YES	208	Multiple Endpoints Mixed Contaminants

[1] COI - chemical of interest is any chemical detected in the media of concern

[2] SCTL for direct contact with soil in an industrial setting, from F.A.C. Chapter 62-777, Table 2, dated May 1999.

[3] Initial human health screening criteria is the SCTL for direct contact divided by 10 to account for multiple chemical effect for carcinogens and noncarcinogens.

[4] Leach I - soil leaching to groundwater, from F.A.C. Chapter 62-777, Table 2, dated May 1999.

[5] The initial screening criteria is the lowest of the adjusted direct contact SCTL or the leaching to groundwater or surface water SCTLs.

TABLE 2-4

SOIL FINAL COPCs

SITE 20, ALLEGHENY PIER (PIER 303)
NAS PENSACOLA, PENSACOLA, FLORIDA

COI [1]	Max Conc. (mg/kg)	SCTL Industrial (mg/kg)[2]	Target System/Organ	Cumulative Cancer or Target Organ/System Analysis[3]				Adj. SCTL Industrial (mg/kg)[4]	SCTL Leach I (mg/kg)[5]	Minimum SCTL (mg/kg)[6]	Final COPCs [7]
				Carcinogen	Body Weight	Nasal	Adj. Factor				
Semivolatile Organics											
1-Methylnaphthalene	48.8	470	Body Weight -Nasal		0.10	17.80	3	156.67	2.2	2.20	YES
2-Methylnaphthalene	71.8	560	Body Weight -Nasal		0.13	7.65	3	186.67	6.1	6.10	YES
Benzo(a)anthracene	1.14	5	Carcinogen	0.23			3	1.67	3.2	1.67	NO
Benzo(a)pyrene	1.04	1	Carcinogen	2.08			3	0.17	8	0.17	YES
Benzo(b)fluoranthene	1.03	4.8	Carcinogen	0.21			3	1.60	10	1.60	NO
TPH	12,400	2,500	Multiple Endpoints Mixed Contaminants		4.96		3	833.33	340	340	YES
			Cumulative Sum =	2.52	5.19	25.45					

[1] COI - chemical of interest.

[2] SCTL for direct contact with soil in an industrial setting, from F.A.C. Chapter 62-777, Table 2, dated May 1999.

[3] The ratio of the maximum detected concentration to the SCTL is shown for each COPC; a ratio or sum of ratios greater than 1 for carcinogens or for any organ/system indicates an exceedance of FDEP guidance (ratios only shown for COIs that exceed direct contact during initial screen).

[4] The SCTL for direct contact with soil in an industrial setting taken from F.A.C. Chapter 62-777, Table 2, was divided by the number (i.e., adj. factor) of carcinogenic COPCs or noncarcinogenic COPCs that affect the same target organ/system to account for cumulative affects.

[5] Leach I - soil leaching to groundwater, per F.A.C. Chapter 62-777, Table 2.

[6] The final screening criteria is the minimum of the following: (a) the adjusted SCTL for industrial soils, (b) the SCTL for leaching to groundwater, (or c) the SCTL for leaching to surface water (where applicable).

[7] A COI is selected as a final COPC if the maximum concentration of that chemical exceeds the minimum SCTL..

Groundwater samples at Site 20 did not exceed FDEP GCTLs for acenaphthene, anthracene, fluoranthene, fluorene, phenanthrene, pyrene, and chrysene. The FDEP GCTL (20 ppb) for naphthalene was exceeded in wells MW-4 (330 ppb), MW-7 (225 ppb), MW-18 (320 ppb), and DMW-54 (4700 ppb). TRPH was detected in 22 monitoring wells and exceeded the FDEP GCTL of 5,000 ppb in 7 of the monitoring wells (MW-4 at 5,400 ppb, MW-7 at 11,000 ppb, MW-17 at 47,000, MW-18 at 10,000 ppb, MW-38 at 82,000 ppb, MW-52 at 14,000 ppb, and DMW-54 at 9,700 ppb). Lead was also detected in 17 wells and exceeded the FDEP GCTL of 0.015 ppm for lead in 6 of these wells (MW-4 at 0.31 ppm, MW-5 at 0.41 ppm, MW-13 at 0.22 ppm, MW-39 at 0.144 ppm, MW-45 at 0.62 ppm, and MW-56 at 0.20 ppm). Groundwater analytical results from the SAR are summarized on Table 2-5.

In July 2000, in preparation of the SARA, 18 of the 59 site monitoring wells were resampled. VOCs were not detected. Eight PAHs were detected. Acenaphthalene was detected in two wells, MW-37 (44.1 ppb) and MW-48 (67.7 ppb), at concentrations exceeding the FDEP GCTL of 20 ppb. TRPH was detected in 13 monitoring wells, but exceeded the GCTL of 5,000 ppb only in the sample collected from MW-18 (10,900 ppb). Lead was detected only in well MW-46 (115 ppb) and exceeded the GCTL of 15 ppb. Table 2-5 summarizes the July 2000 groundwater analytical results.

2.4.1 Identification and Selection of Groundwater COPCs

The COC screening process identified 12 COIs in groundwater whose maximum detected concentrations exceeded the GCTLs. Because groundwater discharges to surface water (i.e., Pensacola Bay), groundwater discharging to marine surface water (MSW) was evaluated. Table 2-6 presents the initial screening process; lists all chemicals detected in groundwater, their maximum concentration, the State of Florida GCTL for drinking water and for MSW; and identifies the COPCs. COIs whose maximum concentration did not exceed the minimum GCTL or MSW CTL were eliminated from further evaluation as COPCs.

As shown in Table 2-7, multiple carcinogens or noncarcinogens affecting the same target organ/system, without primary or secondary standards, were adjusted by dividing the GCTL by the number of carcinogens or noncarcinogens that affect the same target organ or system to account for additive effects.

2.5 FREE-PRODUCT RECOVERY

On December 6, 2000, a free-product assessment was performed during the SARA (TtNUS, 2001). The free product encountered was described as a very viscous material similar to Bunker C oil. Free-product

TABLE 2-5

SUMMARY OF ANALYTES DETECTED IN GROUNDWATER

SITE 20, ALLEGHENY PIER (PIER 303)
NAS PENSACOLA, PENSACOLA, FLORIDA

PAGE 1 OF 8

Well	Date	Benzene	trans-1,2-Dichloroethene	Toluene	Trichloroethene	Vinyl Chloride	Xylenes (Total)	MTBE	Acenaphthene	Anthracene	Chrysene
GCTL		1	100	40	3	1	20	50	20	2100	4.8
SAR											
MW-1	9/10/1996	--	--	--	--	--	--	--	--	--	--
MW-3	9/10/1996	--	--	--	--	--	--	--	[redacted]	--	--
MW-4	9/10/1996	--	--	--	--	--	--	--	--	--	--
MW-5	9/18/1996	--	--	--	--	--	--	--	--	--	
MW-7	9/10/1996	--	2	--	--	[redacted]	--	--	--	--	--
MW-9	9/10/1996	--	--	--	--	--	--	--	--	--	--
MW-10	9/10/1996	--	--	--	--	--	--	--	--	--	--
MW-13	11/6/1996	--	--	--	--	--	--	--	--	--	--
MW-14	11/6/1996	--	--	--	--	--	--	--	--	--	--
MW-16	11/6/1996	--	--	--	--	--	--	--	6	--	--
MW-17	11/6/1996	--	--	--	--	--	--	--	4	--	--
MW-18	11/6/1996	--	--	--	--	--	--	--	16	5	--
MW-21	2/11/1997	--	--	--	--	--	--	--	[redacted]	2	--
MW-22	2/11/1997	--	--	--	--	--	--	--	7	--	--
MW-23	2/11/1997	--	--	--	--	--	--	--	[redacted]	17	
MW-25	2/11/1997	--	--	--	--	--	--	--	6	--	--
MW-26	2/11/1997	--	--	--	--	--	--	--	4	--	--
MW-27	2/27/1997	--	--	--	--	1	--	--	--	--	--
MW-28	2/27/1997	--	--	--	--	[redacted]	--	--	--	--	--
MW-30	2/27/1997	--	--	--	--	--	--	--	--	--	--
MW-35	3/27/1997	--	--	--	--	--	--	--	7		--
MW-37	3/27/1997	--	--	--	--	--	--	--	[redacted]	--	--
MW-38	3/27/1997	--	--	--	--	--	--	--	--	--	
MW-39	3/27/1997	--	--	--	--	--	--	--	--	--	2
MW-40	3/27/1997	--	--	--	2	--	--	--	--	--	--
MW-41	3/27/1997	--	--	--	--	--	--	--	--	--	--
MW-42	5/2/1997	--	--	1	--	--	--	--	[redacted]	--	--
MW-43	5/2/1997	--	--	--	--	--	--	--	[redacted]	--	--
	9/18/1997	--	--	--	--	--	--	--	[redacted]	--	--
MW-44	5/2/1997	--	--	--	--	--	--	--	8	--	--
	9/18/1997	--	--	--	--	--	--	--	[redacted]	--	--
MW-45	5/2/1997	--	--	--	--	--	--	--	--	--	--
MW-46	5/2/1997	--	--	--	--	--	--	--	--	--	--
MW-48	5/21/1997	--	--	--	--	--	--	--	[redacted]	--	--
MW-49	5/21/1997	--	--	--	--	--	--	--	[redacted]	--	--
MW-50	5/21/1997	--	--	--	--	--	2	--	18	--	--
MW-52	5/21/1997	--	--	2	--	--	--	--	--	--	--
DMW-54	5/30/1997	--	--	2	--	--	29	--	[redacted]	28	--

TABLE 2-5

SUMMARY OF ANALYTES DETECTED IN GROUNDWATER

SITE 20, ALLEGHENY PIER (PIER 303)
NAS PENSACOLA, PENSACOLA, FLORIDA

Well	Date	Benzene	trans-1,2-Dichloroethene	Toluene	Trichloroethene	Vinyl Chloride	Xylenes (Total)	MTBE	Acenaphthene	Anthracene	Chrysene
GCTL		1	100	40	3	1	20	50	20	2100	4.8
SAR (Continued)											
DMW-55	5/30/1997	[redacted]	--	--	--	--	2	1	3	--	--
MW-56	5/30/1997	--	--	--	--	--	--	--	15	--	--
MW-57	5/30/1997	--	--	--	--	--	--	--	11	--	--
MW-58	5/30/1997	--	--	--	--	--	--	--	3	--	--
MW-59	5/30/1997	--	--	--	--	--	--	--	16	--	--
SARA											
MW-07	7/20/2000	--	--	--	--	--	--	--	--	--	--
MW-09	7/24/2000	--	--	--	--	--	--	--	--	--	--
MW-10	7/24/2000	--	--	--	--	--	--	--	--	--	--
MW-10 dup	7/24/2000	--	--	--	--	--	--	--	--	--	--
MW-15	7/24/2000	--	--	--	--	--	--	--	--	--	--
MW-18	7/20/2000	--	--	--	--	--	--	--	10.5	--	--
MW-18 dup	7/20/2000	--	--	--	--	--	--	--	8.3	--	--
MW-23	7/24/2000	--	--	--	--	--	--	--	13.6	--	--
MW-27	7/19/2000	--	--	--	--	--	--	--	--	--	--
MW-28	7/19/2000	--	--	--	--	--	--	--	--	--	--
MW-29	7/24/2000	--	--	--	--	--	--	--	2.4	--	--
MW-37	7/20/2000	--	--	--	--	--	--	--	[redacted]	--	--
MW-38	7/19/2000	--	--	--	--	--	--	--	--	--	--
MW-40	7/20/2000	--	--	--	--	--	--	--	--	--	--
MW-46	7/19/2000	--	--	--	--	--	--	--	--	--	--
MW-47	7/24/2000	--	--	--	--	--	--	--	--	--	--
MW-48	7/20/2000	--	--	--	--	--	--	--	[redacted]	--	--
MW-54	7/20/2000	--	--	--	--	--	--	--	--	--	--
MW-55	7/19/2000	--	--	--	--	--	--	--	--	--	--
MW-58	7/24/2000	--	--	--	--	--	--	--	--	--	--

TABLE 2-5

SUMMARY OF ANALYTES DETECTED IN GROUNDWATER

SITE 20, ALLEGHENY PIER (PIER 303)
NAS PENSACOLA, PENSACOLA, FLORIDA

Well	Date	Fluoranthene	Fluorene	1-Methyl Naphthalene	2-Methyl Naphthalene	Naphthalene	Phenanthrene	Pyrene	TRPH	Lead
GCTL		280	280	20	20	20	210	210	5000	15
SAR										
MW-1	9/10/1996	--	--	--	--	--	--	--	--	6
MW-3	9/10/1996	--	--	--	--	--	--	--	--	4
MW-4	9/10/1996	8	14	[illegible]	[illegible]	[illegible]	11	10	[illegible]	[illegible]
MW-5	9/18/1996	--	--	--	--	--	--	--	--	[illegible]
MW-7	9/10/1996	--	5	[illegible]	[illegible]	[illegible]	--	--	[illegible]	4
MW-9	9/10/1996	--	--	[illegible]	[illegible]	--	--	--	600	--
MW-10	9/10/1996	--	--	7	--	--	--	--	--	8
MW-13	11/6/1996	--	--	--	--	--	--	--	--	[illegible]
MW-14	11/6/1996	--	--	--	--	--	--	--	--	8
MW-16	11/6/1996	--	--	4	3	--	--	--	660	--
MW-17	11/6/1996	--	2	[illegible]	[illegible]	--	--	--	[illegible]	--
MW-18	11/6/1996	7	16	[illegible]	[illegible]	[illegible]	14	7	[illegible]	--
MW-21	2/11/1997	--	18	11	7	--	4	--	330	--
MW-22	2/11/1997	--	2	--	--	--	--	--	270	--
MW-23	2/11/1997	7	86	[illegible]	[illegible]	[illegible]	81	4	1130	--
MW-25	2/11/1997	--	--	--	--	--	--	--	--	--
MW-26	2/11/1997	--	--	--	--	--	--	--	370	--
MW-27	2/27/1997	--	--	--	--	--	--	--	--	--
MW-28	2/27/1997	--	--	--	--	--	--	--	250	--
MW-30	2/27/1997	--	--	--	--	--	--	--	--	4
MW-35	3/27/1997	--	--	--	--	14	--	3	2900	--
MW-37	3/27/1997	--	6	3	--	4	2	2	--	--
MW-38	3/27/1997	5	--	13	9	--	--	7	[illegible]	--
MW-39	3/27/1997	5	--	--	--	--	5	5	--	[illegible]
MW-40	3/27/1997	--	--	--	--	--	--	--	--	8
MW-41	3/27/1997	--	--	--	--	--	--	--	--	14
MW-42	5/2/1997	--	4	6	--	--	--	--	970	--
MW-43	5/2/1997	--	--		--	--	--	--	--	--
	9/18/1997	--	15	6	--	--	--	--	--	--
MW-44	5/2/1997	--	--	--	--	--	--	--	--	--
	9/18/1997	--	--	--	--	--	--	--	--	--
MW-45	5/2/1997	--	--	--	--	--	--	--	--	[illegible]
MW-46	5/2/1997	--	--	--	--	--	--	--	--	4
MW-48	5/21/1997	--	--	4	--	--	3	--	310	--
MW-49	5/21/1997	--	25	17	--	--	6	--	360	--
MW-50	5/21/1997	--	--	--	--	--	--	--	390	6
MW-52	5/21/1997	--	--	--	--	--	--	--	14000	--
DMW-54	5/30/1997	15	124	365	[illegible]	1700	118	10	9700	--

TABLE 2-5

SUMMARY OF ANALYTES DETECTED IN GROUNDWATER

SITE 20, ALLEGHENY PIER (PIER 303)
NAS PENSACOLA, PENSACOLA, FLORIDA

Well	Date	Fluoranthene	Fluorene	1-Methyl Naphthalene	2-Methyl Naphthalene	Naphthalene	Phenanthrene	Pyrene	TRPH	Lead
GCTL		280	280	20	20	20	210	210	5000	15
SAR (Continued)										
DMW-55	5/30/1997	--	--	[redacted]	[redacted]	9	--	--	1000	--
MW-56	5/30/1997	--	--	3	--	2	--	--	--	[redacted]
MW-57	5/30/1997	--	--	--	--	--	--	--	550	--
MW-58	5/30/1997	--	--	--	--	--	--	--	--	5
MW-59	5/30/1997	--	--	--	--	--	--	--	1100	--
SARA										
MW-07	7/20/2000	--	--	--	--	--	--	--	2040	--
MW-09	7/24/2000	--	--	3.7	3.6	--	--	--	303	--
MW-10	7/24/2000	--	--	2.9	--	--	--	--	1450	--
MW-10 dup	7/24/2000	--	--	2.5	--	--	--	--	1400	--
MW-15	7/24/2000	--	--	--	--	--	--	--	1940	--
MW-18	7/20/2000	2.7	2.4	6.6	4.3	--	--	2.7	[redacted]	--
MW-18 dup	7/20/2000	2.5	2 J	2.4	2.3	--	--	2.7	[redacted]	--
MW-23	7/24/2000	2.1	--	--	--	--	2.4	--	3280	--
MW-27	7/19/2000	--	--	--	--	--	--	--	520	--
MW-28	7/19/2000	--	--	--	--	--	--	--	447	--
MW-29	7/24/2000	--	2.4	--	2.1J	--	--	--	1400	--
MW-37	7/20/2000	--	12.4	--	--	--	--	--	1450	--
MW-38	7/19/2000	--	--	--	--	--	--	--	280	--
MW-40	7/20/2000	--	--	--	--	--	--	--	--	--
MW-46	7/19/2000	--	--	--	--	--	--	--	250	[redacted]
MW-47	7/24/2000	--	--	--	--	--	--	--	--	--
MW-48	7/20/2000	--	24.8	13	3.8	--	--	--	--	--
MW-54	7/20/2000	--	--	--	--	--	--	--	--	--
MW-55	7/19/2000	--	--	--	--	--	--	--	--	--
MW-58	7/24/2000	--	--	--	--	--	--	--	1530	--

TABLE 2-5

SUMMARY OF ANALYTES DETECTED IN GROUNDWATER

SITE 20, ALLEGHENY PIER (PIER 303)
NAS PENSACOLA, PENSACOLA, FLORIDA

Well	Date	Benzene	trans-1,2-Dichloroethene	Toluene	Trichloroethene	Vinyl Chloride	Xylenes (Total)	MTBE	Acenaphthene	Anthracene	Chrysene
GCTL		1	100	40	3	1	20	50	20	2100	4.8
SAR											
MW-1	9/10/1996	--	--	--	--	--	--	--	--	--	--
MW-3	9/10/1996	--	--	--	--	--	--	--	[redacted]	--	--
MW-4	9/10/1996	--	--	--	--	--	--	--	--	--	
MW-5	9/18/1996	--	--	--	--	--	--	--	--	--	--
MW-7	9/10/1996	--	2	--	--	[redacted]	--	--	--	--	--
MW-9	9/10/1996	--	--	--	--	--	--	--	--	--	--
MW-10	9/10/1996	--	--	--	--	--	--	--	--	--	--
MW-13	11/6/1996	--	--	--	--	--	--	--	--	--	--
MW-14	11/6/1996	--	--	--	--	--	--	--	--	--	--
MW-16	11/6/1996	--	--	--	--	--	--	--	6	--	--
MW-17	11/6/1996	--	--	--	--	--	--	--	4	--	--
MW-18	11/6/1996	--	--	--	--	--	--	--	16	5	--
MW-21	2/11/1997	--	--	--	--	--	--	--	[redacted]	2	--
MW-22	2/11/1997	--	--	--	--	--	--	--	7	--	--
MW-23	2/11/1997	--	--	--	--	--	--	--	[redacted]	17	
MW-25	2/11/1997	--	--	--	--	--	--	--	6	--	--
MW-26	2/11/1997	--	--	--	--	--	--	--	4	--	--
MW-27	2/27/1997	--	--	--	--	1	--	--	--	--	--
MW-28	2/27/1997	--	--	--	--	[redacted]	--	--	--	--	--
MW-30	2/27/1997	--	--	--	--	--	--	--	--	--	--
MW-35	3/27/1997	--	--	--	--	--	--	--	7		--
MW-37	3/27/1997	--	--	--	--	--	--	--	[redacted]	--	--
MW-38	3/27/1997	--	--	--	--	--	--	--	--	--	
MW-39	3/27/1997	--	--	--	--	--	--	--	--	--	2
MW-40	3/27/1997	--	--	--	2	--	--	--	--	--	--
MW-41	3/27/1997	--	--	--	--	--	--	--	--	--	--
MW-42	5/2/1997	--	--	1	--	--	--	--	[redacted]	--	--
MW-43	5/2/1997	--	--	--	--	--	--	--	[redacted]	--	--
	9/18/1997	--	--	--	--	--	--	--	[redacted]	--	--
MW-44	5/2/1997	--	--	--	--	--	--	--	8	--	--
	9/18/1997	--	--	--	--	--	--	--	[redacted]	--	--
MW-45	5/2/1997	--	--	--	--	--	--	--	--	--	--
MW-46	5/2/1997	--	--	--	--	--	--	--	--	--	--
MW-48	5/21/1997	--	--	--	--	--	--	--	[redacted]	--	--
MW-49	5/21/1997	--	--	--	--	--	--	--	[redacted]	--	--
MW-50	5/21/1997	--	--	--	--	--	2	--	18	--	--
MW-52	5/21/1997	--	--	2	--	--	--	--	--	--	--
DMW-54	5/30/1997	--	--	2	--	--	29	--	207	28	--

TABLE 2-5

SUMMARY OF ANALYTES DETECTED IN GROUNDWATER

SITE 20, ALLEGHENY PIER (PIER 303)
NAS PENSACOLA, PENSACOLA, FLORIDA

Well	Date	Benzene	trans-1,2-Dichloroethene	Toluene	Trichloroethene	Vinyl Chloride	Xylenes (Total)	MTBE	Acenaphthene	Anthracene	Chrysene
GCTL		1	100	40	3	1	20	50	20	2100	4.8
SAR (Continued)											
DMW-55	5/30/1997	2	--	--	--	--	2	1	3	--	--
MW-56	5/30/1997	--	--	--	--	--	--	--	15	--	--
MW-57	5/30/1997	--	--	--	--	--	--	--	11	--	--
MW-58	5/30/1997	--	--	--	--	--	--	--	3	--	--
MW-59	5/30/1997	--	--	--	--	--	--	--	16	--	--
SARA											
MW-07	7/20/2000	--	--	--	--	--	--	--	--	--	--
MW-09	7/24/2000	--	--	--	--	--	--	--	--	--	--
MW-10	7/24/2000	--	--	--	--	--	--	--	--	--	--
MW-10 dup	7/24/2000	--	--	--	--	--	--	--	--	--	--
MW-15	7/24/2000	--	--	--	--	--	--	--	--	--	--
MW-18	7/20/2000	--	--	--	--	--	--	--	10.5	--	--
MW-18 dup	7/20/2000	--	--	--	--	--	--	--	8.3	--	--
MW-23	7/24/2000	--	--	--	--	--	--	--	13.6	--	--
MW-27	7/19/2000	--	--	--	--	--	--	--	--	--	--
MW-28	7/19/2000	--	--	--	--	--	--	--	--	--	--
MW-29	7/24/2000	--	--	--	--	--	--	--	2.4	--	--
MW-37	7/20/2000	--	--	--	--	--	--	--	[illegible]	--	--
MW-38	7/19/2000	--	--	--	--	--	--	--	--	--	--
MW-40	7/20/2000	--	--	--	--	--	--	--	--	--	--
MW-46	7/19/2000	--	--	--	--	--	--	--	--	--	--
MW-47	7/24/2000	--	--	--	--	--	--	--	--	--	--
MW-48	7/20/2000	--	--	--	--	--	--	--	[illegible]	--	--
MW-54	7/20/2000	--	--	--	--	--	--	--	--	--	--
MW-55	7/19/2000	--	--	--	--	--	--	--	--	--	--
MW-58	7/24/2000	--	--	--	--	--	--	--	--	--	--

TABLE 2-5

SUMMARY OF ANALYTES DETECTED IN GROUNDWATER

SITE 20, ALLEGHENY PIER (PIER 303)
NAS PENSACOLA, PENSACOLA, FLORIDA

Well	Date	Fluoranthene	Fluorene	1-Methyl Naphthalene	2-Methyl Naphthalene	Naphthalene	Phenanthrene	Pyrene	TRPH	Lead
GCTL		280	280	20	20	20	210	210	5000	15
SAR										
MW-1	9/10/1996	--	--	--	--	--	--	--	--	6
MW-3	9/10/1996	--	--	--	--	--	--	--	--	4
MW-4	9/10/1996	8	14	[redacted]	[redacted]	[redacted]	11	10	[redacted]	31
MW-5	9/18/1996	--	--	--	--	--	--	--	--	41
MW-7	9/10/1996	--	5	[redacted]	[redacted]	[redacted]	--	--	[redacted]	4
MW-9	9/10/1996	--	--	[redacted]	[redacted]	--	--	--	600	--
MW-10	9/10/1996	--	--	7	--	--	--	--	--	8
MW-13	11/6/1996	--	--	--	--	--	--	--	--	22
MW-14	11/6/1996	--	--	--	--	--	--	--	--	8
MW-16	11/6/1996	--	--	4	3	--	--	--	660	--
MW-17	11/6/1996	--	2	[redacted]	[redacted]	--	--	--	[redacted]	--
MW-18	11/6/1996	7	16	[redacted]	[redacted]	[redacted]	14	7	[redacted]	--
MW-21	2/11/1997	--	18	11	7	--	4	--	330	--
MW-22	2/11/1997	--	2	--	--	--	--	--	270	--
MW-23	2/11/1997	7	86	[redacted]	[redacted]	[redacted]	81	4	1130	--
MW-25	2/11/1997	--	--	--	--	--	--	--	--	--
MW-26	2/11/1997	--	--	--	--	--	--	--	370	--
MW-27	2/27/1997	--	--	--	--	--	--	--	--	--
MW-28	2/27/1997	--	--	--	--	--	--	--	250	--
MW-30	2/27/1997	--	--	--	--	--	--	--	--	4
MW-35	3/27/1997	--	--	--	--	14	--	3	2900	--
MW-37	3/27/1997	--	6	3	--	4	2	2	--	--
MW-38	3/27/1997	5	--	13	9	--	--	7	[redacted]	--
MW-39	3/27/1997	5	--	--	--	--	5	5	--	144
MW-40	3/27/1997	--	--	--	--	--	--	--	--	8
MW-41	3/27/1997	--	--	--	--	--	--	--	--	14
MW-42	5/2/1997	--	4	6	--	--	--	--	970	--
MW-43	5/2/1997	--	--		--	--	--	--	--	--
	9/18/1997	--	15	6	--	--	--	--	--	--
MW-44	5/2/1997	--	--	--	--	--	--	--	--	--
	9/18/1997	--	--	--	--	--	--	--	--	--
MW-45	5/2/1997	--	--	--	--	--	--	--	--	62
MW-46	5/2/1997	--	--	--	--	--	--	--	--	4
MW-48	5/21/1997	--	--	4	--	--	3	--	310	--
MW-49	5/21/1997	--	25	17	--	--	6	--	360	--
MW-50	5/21/1997	--	--	--	--	--	--	--	390	6
MW-52	5/21/1997	--	--	--	--	--	--	--	[redacted]	--
DMW-54	5/30/1997	15	124	[redacted]	[redacted]	[redacted]	118	10	[redacted]	--

TABLE 2-5

SUMMARY OF ANALYTES DETECTED IN GROUNDWATER

SITE 20, ALLEGHENY PIER (PIER 303)
NAS PENSACOLA, PENSACOLA, FLORIDA

Well	Date	Fluoranthene	Fluorene	1-Methyl Naphthalene	2-Methyl Naphthalene	Naphthalene	Phenanthrene	Pyrene	TRPH	Lead
GCTL		280	280	20	20	20	210	210	5000	15
SAR (Continued)										
DMW-55	5/30/1997	--	--	42	28	9	--	--	1000	--
MW-56	5/30/1997	--	--	3	--	2	--	--	--	20
MW-57	5/30/1997	--	--	--	--	--	--	--	550	--
MW-58	5/30/1997	--	--	--	--	--	--	--	--	5
MW-59	5/30/1997	--	--	--	--	--	--	--	1100	--
SARA										
MW-07	7/20/2000	--	--	--	--	--	--	--	2040	--
MW-09	7/24/2000	--	--	3.7	3.6	--	--	--	303	--
MW-10	7/24/2000	--	--	2.9	--	--	--	--	1450	--
MW-10 dup	7/24/2000	--	--	2.5	--	--	--	--	1400	--
MW-15	7/24/2000	--	--	--	--	--	--	--	1940	--
MW-18	7/20/2000	2.7	2.4	6.6	4.3	--	--	2.7	[illegible]	--
MW-18 dup	7/20/2000	2.5	2 J	2.4	2.3	--	--	2.7	[illegible]	--
MW-23	7/24/2000	2.1	--	--	--	--	2.4	--	3280	--
MW-27	7/19/2000	--	--	--	--	--	--	--	520	--
MW-28	7/19/2000	--	--	--	--	--	--	--	447	--
MW-29	7/24/2000	--	2.4	--	2.1J	--	--	--	1400	--
MW-37	7/20/2000	--	12.4	--	--	--	--	--	1450	--
MW-38	7/19/2000	--	--	--	--	--	--	--	280	--
MW-40	7/20/2000	--	--	--	--	--	--	--	--	--
MW-46	7/19/2000	--	--	--	--	--	--	--	250	115
MW-47	7/24/2000	--	--	--	--	--	--	--	--	--
MW-48	7/20/2000	--	24.8	13	3.8	--	--	--	--	--
MW-54	7/20/2000	--	--	--	--	--	--	--	--	--
MW-55	7/19/2000	--	--	--	--	--	--	--	--	--
MW-58	7/24/2000	--	--	--	--	--	--	--	1530	--

Notes:
All concentrations in micrograms per liter ($\mu g/L$).
Groundwater Cleanup Criteria as provided in Chapter 62-777, F.A.C.
"J" indicates the presence of a chemical at an estimated concentration.
Shaded cells indicate exceedance of GCTLs as provided in Chapter 62-777, F.A.C.
-- Entry indicates analyte not detected above method detection limit.

TABLE 2-6

SELECTION OF GROUNDWATER COCs

SITE 20, ALLEGHENY PIER (PIER 303)
NAS PENSACOLA, PENSACOLA, FLORIDA

COI [1]	Max Conc. (µg/L)	GW CTL (µg/L)	Adjusted GCTL for GW (µg/l)[2]	MSW CTL (µg/L)[3]	Exceeds Direct Contact	Initial Screening Criteria (µg/L)[4]	Criteria Type[5]	Target System/Organ
Volatile Organics								
benzene	2	1	1	71.28	YES	1	P	Carcinogen
trans-1,2-Dichloroethene	2	100	100	11000	NO	100.00	P	Blood -Liver
toluene	2	40	40	475	NO	40.00	S	Kidney -Liver -Neurological
trichloroethene	2	3	3	80.7	NO	3.00	P	Carcinogen
vinyl chloride	37	1	1	NA	YES	1.00	P	Carcinogen
xylenes, total	29	20	20	370	YES	20.00	S	Body Weight -Mortality -Neurological
methyl tert-butyl ether	1	50	12.5	33600	NO	12.50		Eye -Kidney -Liver
Semivolatile Organics								
acenaphthene	207	20	6.7	3	YES	3.00		Liver
anthracene	28	2100	2100	0.3	NO	0.3		None Specified
chrysene	2	4.8	4.8	0.031	NO	0.031		Carcinogen
fluoranthene	15	280	70	0.3	NO	0.3		Blood -Kidney -Liver
fluorene	124	280	140	30	NO	30.00		Blood
1-methylnaphthalene	540	20	6.7	95	YES	6.7		Body Weight -Nasal
2-methylnaphthalene	580	20	6.7	30	YES	6.7		Body Weight -Nasal
naphthalene	4700	20	6.7	26	YES	6.7		Body Weight -Nasal
phenanthrene	118	210	52.5	0.031	YES	0.031		Kidney
pyrene	10	210	52.5	0.3	NO	0.3		Kidney
TRPH	82000	5000	5000	5000	YES	5000		Multiple Endpoints Mixed Contaminants
Inorganics								
Lead	144	15	15	5.6	YES	5.6	P	Neurological

1 COI - chemical of interest
2 GCTLs based on Primary and Secondary Standards were not adjusted. The derived GCTLs for ingestion of groundwater taken from F.A.C. Chapter 62-777 Table 1, were divided by the number of carcinogens or noncarcinogens that affect the same target organ or system to account for additive effects.
3 The CTL for protection of marine surface water (MSW), per F.A.C. Chapter 62-777, Table 1, dated May 1999.
4 The initial screening criteria is the minimum of the GCTL, the adjusted GCTL, or the CTL to protect marine surface water.
5 P - primary drinking water standard; S - secondary drinking water standard; per F.A.C. Chapter 62-550 and Chapter 62-777, Table 1.

TABLE 2-7

GROUNDWATER FINAL COPCs

SITE 20, ALLEGHENY PIER (PIER 303)
NAS PENSACOLA, PENSACOLA, FLORIDA

COI [1]	Max Conc. (ug/L)	GW CTL (ug/L)	Criteria Type [2]	Target System/Organ	Cumulative Cancer or Target Organ/System Analysis [3]: Carcinogen	Body Weight	Nasal	Kidney	Liver	Blood	Mortality	Neurological	Adj. Factor	Adj. GCTL (ug/L) [4]	MSW CTL (ug/L) [5]	Minimum GCTL (ug/L) [6]	Final COPCs [7]
Volatile Organics																	
Benzene	2	1	P	Carcinogen	2									1	71.28	1	YES
Vinyl Chloride	37	1	P	Carcinogen	37									1	NA	1	YES
Xylenes, Total	29	20	S	Body Weight -Mortality -Neurologica		1.45					1.45	1.45		20	370	20	YES
Semivolatile Organics																	
Acenaphthene	207	20		Liver					10.35				1	20	3	3	YES
Chrysene	2	4.8		Carcinogen	0.417								1	4.8	0.031	0.03	YES
Fluorene	124	280		Blood						0.443			1	280	30	30	YES
1-methylnaphthalene	540	20		Body Weight -Nasal		27	27						3	6.7	95	6.7	YES
2-methylnaphthalene	580	20		Body Weight -Nasal		29	29						3	6.7	30	6.7	YES
Naphthalene	4700	20		Body Weight -Nasal		235	235						3	6.7	26	6.7	YES
Phenanthrene	118	210		Kidney				0.562					1	210.0	0.031	0.03	YES
TPH	82000	5000		Multiple Endpoints Mixed Contaminant:									1	5000	5000	5000	YES
Inorganics																	
Lead	144	15	P	Neurological								9.6		15	5.6	5.6	YES
				Cumulative Sum =	39.4	292.5	291.0	0.6	10.4	0.4	1.5	11.1					

[1] COI - chemical of interest

[2] P - primary drinking water standard; S - secondary drinking water standard; per F.A.C. Chapter 62-550 and Chapter 62-777, Table 1.

[3] The ratio of the maximum detected concentration to the GCTL is shown for each COPC; a ratio or sum of ratios greater than 1 for carcinogens or for any organ/system indicates an exceedance of FDEP guidance (ratios only shown for COIs that exceed direct contact during initial screen).

[4] GCTLs based on Primary (P) or Secondary (S) Standards were not adjusted. The derived GCTLs for ingestion of groundwater taken from F.A.C 62-777, Table 1, were divided by the number of carcinogens or noncarcinogens that affect the same target organ or system to account for additive effects.

[5] The CTL for protection of marine surface water (MSW), per F.A.C. Chapter 62-777, Table 1, dated May 1999.

[6] The minimum screening criteria is the minimum of the GCTL, the adjusted GCTL, or the CTL to protect marine surface water.

[7] A COI is selected as an final COPC if the maximum concentration exceeds the minimum screening critiera.

measurements recorded during the survey indicated 11 monitoring wells contained free product ranging in thickness from 0.04 foot to 1.42 feet. Free product and water level measurements are summarized in Table 2-1. The estimated extent of free product present at the site, as indicated in the SARA (TtNUS, 2001), is presented on Figure 2-5.

2.6 SITE ASSESSMENT REPORT ADDENDUM (SARA) CONCLUSIONS

The most recent investigative data for the site from the SARA (TtNUS, 2001) concluded the following:

- A Bunker C oil type free-product plume is present at the site over an approximately 102,000 square foot area with a thickness up to 1.42 feet.

- Current and historic groundwater flow data indicate that flow is typically stagnant in the study area.

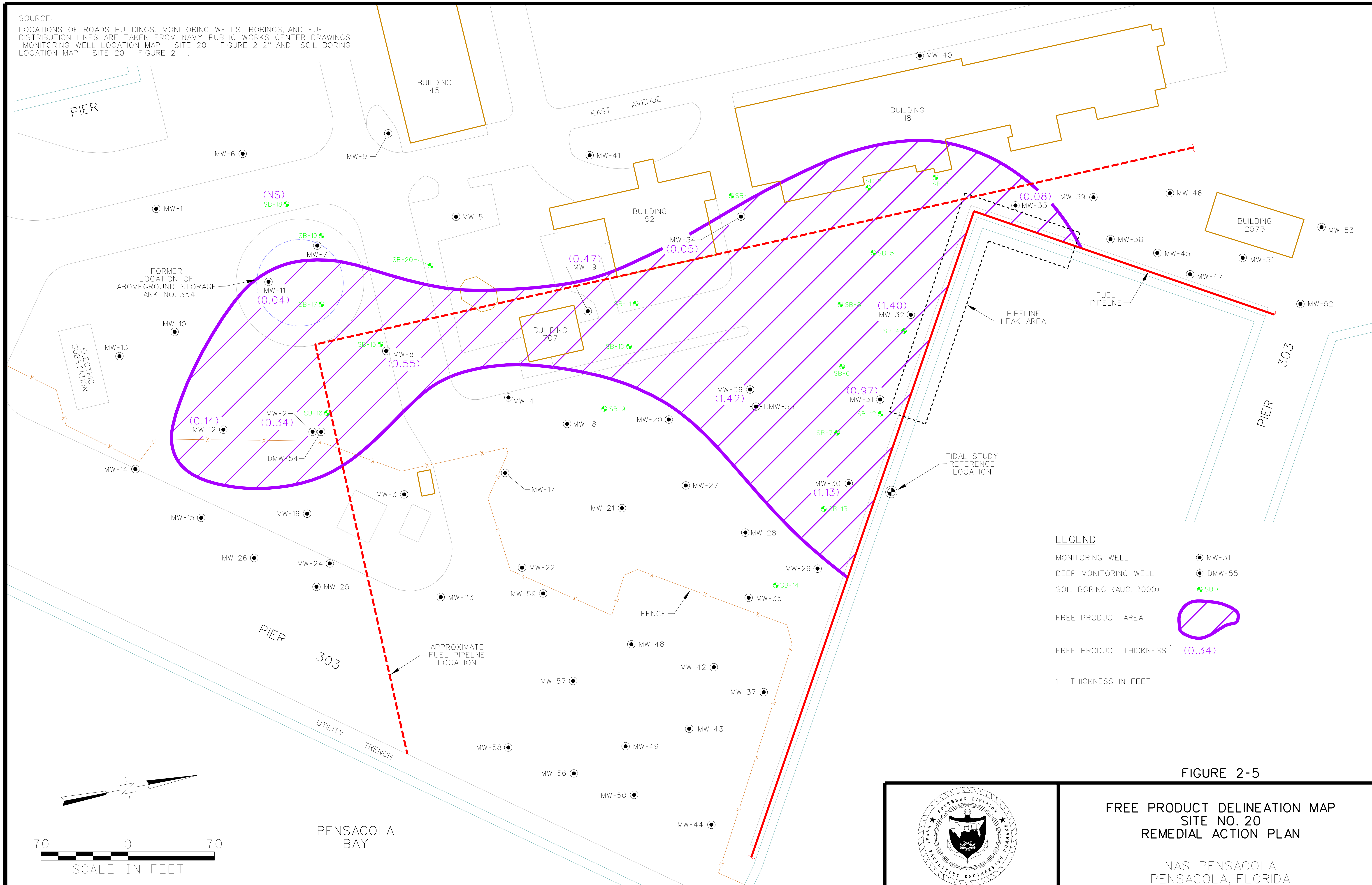
- Groundwater samples collected from on-site monitoring wells MW-18, MW-37, MW-46, and MW-48 contained analytes at concentrations exceeding FDEP's GCTLs.

  Soil samples from 13 on-site soil borings (SB-1, SB-2, SB-3, SB-4, SB-8, SB-10, SB-11, SB-12, SB-15, SB-16, SB-17, SB-19, and SB-20) contained analytes that exceeded FDEP's leachability for groundwater limits and direct exposure limits from Chapter 62-777, F. A. C. Because the soil samples were collected from depths of 5 to 9 feet bls and the majority of the site is asphalt or concrete covered, a direct exposure is unlikely to occur. Leaching to groundwater is also limited due to the asphalt or concrete cover.

- Benzo(a)pyrene was detected in a soil sample from one soil boring (SB-15) at a concentration that exceeded the FDEP's direct exposure limits for both residential (0.1 mg/kg) and industrial areas (0.5 mg/kg) from Chapter 62-777, F.A.C. However, given that the soil sample was collected from a depth of 8 feet bls and the majority of the site is covered, a direct exposure is unlikely to occur.

- A reevaluation of the SAR and SARA data found the estimated average hydraulic gradient to be 0.00052 feet/foot. Using a hydraulic conductivity of 3.123 X 10^{-4} feet/second and porosity of 0.15, the estimated groundwater seepage velocity is 34.1 feet/year. This site is tidally influenced; therefore, the hydraulic gradient is likely a result, to some degree, of this influence.

- The SARA recommended preparing a RAP for free product for the site.



n11x17b.dgn

CAD FILE NO./DATE: k:\dgn\navy\pensacola\ 0401L\ 0401L010.dgn/10-25-01

2.7 SAR AND SARA FINDINGS FOR REMEDIAL ACTION CONSIDERATION

The SAR for Site 20 stated that the fuel released at the site was Bunker C fuel oil. Bunker C fuel oil is a sticky, black liquid similar in appearance and smell to asphalt sealing compounds and has been used to generally describe thick and sticky residual fuel (Environment Canada, 1996).

At 50° F, Bunker C fuel oil has a consistency of liquid honey or corn syrup; at 32° F, it barely flows. Bunker C fuel oil, in addition to being used in the majority of large marine diesel engines, is used in power generating stations, industrial boilers and furnaces, and pumping plants. Because Bunker C fuel oil is less dense than water, fresh Bunker C fuel oil will float in water. As the oil ages or "weathers," it becomes heavier, but it will still float under most conditions. When the oil comes into contact with sediment, sand, or other soil materials, it may adhere together forming lumps or tar balls.

It is expected that due to the age of the tank (1920s) and the chemical properties of Bunker C fuel oil, the weathered fuel is affixed to the soil and, as a result, a minimal groundwater plume is prevalent at the site. The findings of the SAR and SARA support this assumption. In addition, the stained soil samples collected and analyzed during the investigations determined that although some volatile and semivolatile compounds were detected above residential and leachability SCTLs, the primary contaminant was TRPH, which was detected at concentrations exceeding the direct exposure and leachability limits for TRPH. However, because the majority of the site is asphalt or concrete covered, a direct exposure is unlikely to occur and leaching to groundwater is also limited.

3.0 REMEDIAL ACTION OBJECTIVES

Remedial action objectives are aimed at protecting human health and the environment and are expressed for each medium of concern. At Site 20, the media of concern include groundwater, surface soil, and subsurface soil. All exposure scenarios for human health receptors used the State of Florida Chapter 62-777 F.A.C. cleanup target levels (CTL's) criteria. The current and future use of the property at Site 20 is industrial. Based on the current and future use receptors, the following remedial action objectives were developed for Site 20.

Groundwater

1. Prevent ingestion of aquifer groundwater containing carcinogens in excess of State of Florida GCTLs (Chapter 62-777, F.A.C.) for groundwater criteria.
2. Prevent ingestion of aquifer groundwater containing noncarcinogens in excess of the State of Florida GCTLs (Chapter 62-777, F.A.C.) groundwater criteria. The Hazard Quotient (HQ) for each chemical shall not exceed 1.0 for the residential/industrial exposure to groundwater. The Hazard Index (HI)(which is the sum of HQs) shall not exceed 1.0 for the residential/industrial exposure to groundwater.
3. Restore the groundwater aquifer to the State of Florida GCTLs (Chapter 62-777, F.A.C.) for groundwater criteria.

Surface and Subsurface Soil

1. Protect human health from carcinogenic and noncarcinogenic risks associated with incidental ingestion of, inhalation of, and contact with contaminated soil in excess of the State of Florida soil SCTLs (Chapter 62-777, F.A.C.) for commercial/industrial criteria.
2. Prevent leaching of chemicals from soil that would result in groundwater concentrations or marine surface water concentrations that do not meet the remedial action objectives for groundwater.
3. Protect the environment from excessively contaminated soil as defined in Chapter 62-770.200, F.A.C.

3.1 FREE- PRODUCT TARGET LEVELS

Chapter 62-770, F.A.C. defines free product as petroleum or petroleum product in excess of 0.01 foot in thickness, measured at its thickest point, floating on surface water or groundwater. As a result of this definition, the remedial action goal for free-product removal at Site 20 will be to remove free product in excess of 0.01 foot.

3.2 RESTRICTIVE SITE CHARACTERISTICS

Site 20 is located along the Pensacola Bay shoreline and includes a loading area adjacent to the pier seawall. The remaining area of Site 20 consists of a busy parking lot and several buildings with numerous utilities. These restrictions may reduce the remedial options available for Site 20.

4.0 CONTAMINANT DISTRIBUTION

4.1 ESTIMATED AMOUNT OF FREE PRODUCT

Site 20 is the location of a former 1,300,000-gallon aboveground storage tank that contained Navy Special fuel, Marine Diesel fuel, and JP-5 fuel. A leak was discovered in 1981 in the fuel pipeline leading from the tank to the berthing pier while a contractor was driving piles for the pier. The pipelines appear to have been inactive for several years, and either the lines were broken during the years of usage or the abandoned lines contained product when penetrated by the piles. In either event, an unknown quantity of fuel was released. Chapter 62-770, F.A.C. requires the removal of free product in excess of 0.01 foot.

Lateral limits of the free-product plume have been defined through previous investigations as depicted in Figure 2-5. The lateral limits are based on the product release location and the free product located in monitoring wells. Based on the estimated lateral limits of the free-product plume and specific site characteristics, the total volume of free product is estimated at approximately 5,700 gallons based on the de Pastrovich method (USEPA, 1996). Free-product volume calculations are provided in Appendix A.

Calculating the volume of free product in the subsurface is an estimate, and actual product volumes can vary significantly. The contaminant distribution estimate is based on data obtained during the SARA. Estimating the volume of product in the subsurface from product thickness in monitoring wells has several limitations. These limitations include the observed change in free-product thickness due to water table fluctuation, even if the actual volume of free product has not changed. This method does not account for residual and trapped petroleum hydrocarbons of which a portion can be returned to the free-product fraction with water table fluctuations, and the method does not account for spatial variability of aquifer parameters which are rarely represented adequately by "average" properties. However, despite these limitations, this method of estimation is widely used in practice (USEPA, 1996).

4.2 ESTIMATED VOLUME OF SOIL CONTAMINATION

Estimates of contaminated media volumes are made by identifying the areas exceeding the commercial/industrial target levels (CTLs). Soil analysis data were compared with the corresponding CTLs and contaminated soil area maps were prepared. Field investigations conducted as part of the SAR and SARA included soil samples collected at depths ranging from 0 to 1 foot bls constituting surface soil, 2 to 4 feet bls representing subsurface soil, and at 5 to 7 feet bls as saturated zone soil. The estimated area of contaminated surface soil is approximately 78,400 ft^2. The volume estimate indicates a total of approximately 2,900 yd^3 of surface soil that is impacted above SCTLs. The estimated area of contaminated subsurface soil is approximately 78,400 ft^2. The volume estimate indicates a total of approximately 5,800 yd^3 of subsurface soil that is impacted above SCTLs. Soil samples collected within the water table are considered a groundwater contamination. The estimated area of contaminated saturated soil is approximately 95,550 ft^2, which indicates a volume of approximately 7,080 yd^3 of saturated soil that is impacted above SCTLs.

TRPH is the only contaminant found at Site 20 that exceeds the industrial direct exposure limit. The site is primarily covered by asphalt and concrete significantly reducing the likelihood of a direct exposure. Land use controls (LUCs) will be implemented as part of the remedial actions taken at Site 20. The LUCs will ensure that appropriate restrictions on land use are implemented and posting of signs will inform anyone who may need to do intrusive work in the area of appropriate required personal protective equipment. No active remedial action will be evaluated to address contaminated soil at Site 20.

4.3 ESTIMATED MASS OF GROUNDWATER AND CONTAMINANTS

The vertical and horizontal extents of contaminated groundwater are estimated from monitoring well measurements and analytical results from the SAR and SARA. The estimated lateral extent of 153,000 ft^2 is depicted in Figure 4-1. The vertical extent or thickness of contaminated groundwater was assumed to be 11.5 feet, based on the absence of contaminants in the deep monitoring wells DMW-54 and DWM-55. The estimated volume of contaminated groundwater is 3,948,318 gallons. The estimated dissolved mass of TRPH and total lead in the groundwater plume, as defined by the estimated vertical and horizontal extents, are 221.8 pounds and 0.72 pounds, respectively. Calculations are presented in Appendix B.

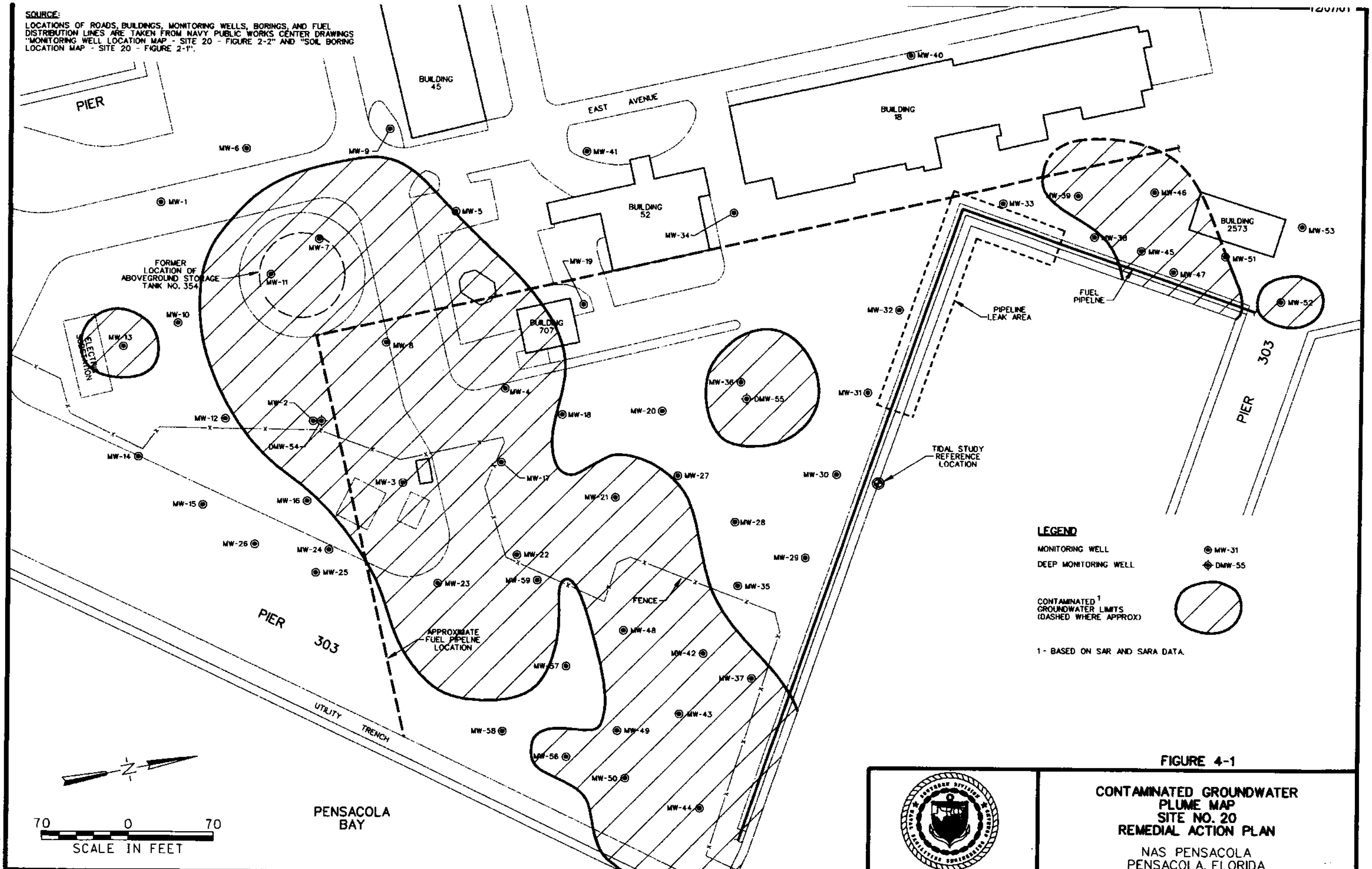


FIGURE 4-1

CONTAMINATED GROUNDWATER PLUME MAP
SITE NO. 20
REMEDIAL ACTION PLAN
NAS PENSACOLA
PENSACOLA, FLORIDA

471001807 ATE: k:\dgn\navy\pensacola\ 0401L\ 0401L012.dgn/11-30-01

CTO 0112

5.0 REMEDIAL TECHNOLOGIES

5.1 IDENTIFICATION AND SCREENING OF FREE-PRODUCT REMOVAL REMEDIAL TECHNOLOGIES

The concerns for Site 20 include free product, surface soil, subsurface soil, and groundwater. Technologies are identified that address the concerns for the site. Each technology is screened based on effectiveness, implementability, cost, and site and contaminant characteristics.

Table 5-1 presents free-product remedial technologies that are potentially applicable for addressing free product at Site 20. This table also presents the results of the screening of those technologies. The technology screening process reduces the number of potentially applicable technologies by evaluating of each technology with regard to effectiveness, implementability, and cost. Technologies deemed ineffective or not implementable were eliminated from further consideration.

5.1.1 Free-Product Removal Using Skimming Systems

Although skimming systems are most efficient when applied to open excavations such as trenches, the location of utilities in the area would make the installation of a trench difficult. Therefore, implementation of a skimming system at Site 20 would be accomplished by utilizing existing site monitoring wells and/or new free-product recovery wells.

Due to the low thickness of free product measured in 8 of the 11 wells containing free product, a mechanical skimming system would be inefficient because it would operate for a short period of time before shutting down and then activate again several hours later. This cycle would result in a very small amount of time when the system would actively be removing the free product. The viscosity of the Bunker C fuel may also make a mechanical skimming system problematic due to clogging of screens or intake valves.

A passive skimming system utilizing filter canisters would encounter problems with clogging screens due to the viscosity of the product. Therefore, a passive system utilizing absorbent socks is the most viable skimming system device.

5.1.2 Free-Product Recovery with Water Table Depression

This method of recovery creates a depression in the water table so that free product is directed toward pumping wells within the plume area. Both free product and groundwater are extracted during recovery

TABLE 5-1

PRELIMINARY SCREENING OF REMEDIAL ACTION TECHNOLOGIES

SITE 20, ALLEGHENY PIER (PIER 303)
NAS PENSACOLA, PENSACOLA, FLORIDA

Remedial Goal	General Remedial Action	Remedial Action Technology	Technology	Description	General Screening Comments
Free-Product Recovery	Institutional Controls	Access Restrictions	Land Use Controls (LUCs)	Zoning regulations in the area of free product would involve restrictions on groundwater use and installation of new wells.	Retained: LUCs are viable and will be considered where no active remediation is required due to limited contamination or in combination with any technology where contaminants exceeding RAP objectives remain in place.
	Monitoring	Monitoring	Free product measurements	Periodic measurements of free-product thickness in the area of potential free-product contamination.	Retained: Monitoring is viable for addressing the effectiveness of containment measures during and following implementation of remedial actions.
	Removal	Free-Product Extraction	Passive skimming	Undissolved liquid phase organics are removed from subsurface formation using filter canisters or absorbent socks.	Retained: Passive skimmers are effective for removing limited quantities of free product.
			Mechanical skimming	Free product is removed using pneumatic pumps.	Eliminated because of low free-product thickness over much of the site and the viscosity of the product.
			Water Table Depression	Free product is recovered from a well or trench along with groundwater. Groundwater is pumped to create a cone of depression in water table to expand area of influence.	Retained.
			Aggressive Fluid Vapor Recovery	Vacuum is applied to well(s) above water table to recover vapor phase and residual hydrocarbons. Both liquids and vapors are recovered from the same well. Groundwater production is minimized and water table is stabilized.	Retained.
Groundwater Remediation	Natural Attenuation	Natural Attenuation	Natural Attenuation	Groundwater monitoring of natural attenuation parameters and COCs.	Eliminated as a stand-alone option, but could become viable following free-product recovery.
	In situ Bioremediation	In situ Bioremediation	ORC Injection	Use DPT to inject ORC® into subsurface.	Eliminated. Lead is not biodegradable, but may become viable following lead removal.
	Pump and Treat	Groundwater Extraction	Groundwater Extraction from wells	Install groundwater extraction wells housing conventional pumps. Extract groundwater for treatment and disposal.	Retained.

operations as the pump removes free product and water from the subsurface. The design of these systems is constrained by the need to minimize drawdown of the water table because minimizing drawdown will reduce both the volume of co-produced water as well as the smearing of free product along the drawdown surface.

Product recovery systems using water table depressions are most applicable when hydraulic control of the hydrocarbon plume is necessary. These systems can operate in a wide range of permeability values and geologic media. Typically, free-product recovery with water table depression is used in long-term operations of greater than 1 year (USEPA, 1996).

To accomplish free-product removal with groundwater depression, a specialized pump would be installed in recovery wells. The free product and groundwater would be removed from recovery wells, where the free product would be stored in drums on-site and the groundwater treated and discharged. Free-product recovery using groundwater depression can generate large quantities of co-produced groundwater. Two options for the disposal of recovered groundwater include publicly owned treatment work (POTW) discharge or treatment and recharge to the water-bearing geologic formation. Because of the cost of treating contaminated groundwater, discharging it to the POTW is preferred (provided the facility will accept discharges). Some pretreatment, such as phase separation, may be required before discharging to the sanitary sewer.

5.1.3 Free-Product Recovery With Aggressive Fluid Vapor Recovery

The approach of aggressive fluid vapor recovery (AFVR) is to extract free product and vapor by vacuum enhanced pumping techniques. Dual-phase systems recover free product and facilitate vapor-based unsaturated zone cleanup through each well point (USEPA, 1996). This approach has several benefits compared to other free-product recovery methods. A cone of depression is not formed at the air/oil interface or the air/water interface; therefore, smearing of the free-product zone is minimized. Vapor-phase hydrocarbons and mobile free product are collected simultaneously.

There are two main conceptual approaches to dual-phase recovery, although they differ only in the vertical positioning of the pump intake: (1) recovery of free product and water by a single vacuum/liquids pump and (2) extraction of free product, air, and water with a single pump and a vacuum extraction point set at the air/product interface (commonly referred to as “bioslurping”).

Dual-phase extraction can be applied using either an in situ system or via specialized mobile vacuum trucks. The use of mobile vacuum trucks is a variation of multi-phase/dual-phase extraction and is also known as AFVR, mobile multi-phase extraction, or mobile dual-phase extraction. For the RAP this technology will be referred to as AFVR. Permanent dual-phase extraction systems typically involve large capital costs for equipment and installation. Permanent dual-phase recovery systems are also typically used for long-term operations. AFVR allows sites with small amounts of free product to be remediated via dual-phase extraction with low capital cost. A mobile vacuum truck equipped for AFVR would eliminate the need for an on-site remedial system for free-product removal. An AFVR contractor reported that the radius of influence for sites could range from 20 to 200 feet. However, with the site conditions and type of product present at Site 20 the radius of influence would most likely range from 25 to 50 feet from the extraction point.

Dual-phase recovery systems are most applicable in medium to low permeability media or thin (less than 0.5 foot) saturated thickness, with water table depths of 5 to 20 feet, settings in which conventional pumping approaches or trenches are inappropriate or ineffective, and free-product plumes are located under paved or sealed surfaces (USEPA, 1996).

5.2 DEVELOPMENT OF FREE-PRODUCT REMOVAL ALTERNATIVES

The technologies that passed the preliminary screening are selected to represent a typical general remedial action and are assembled into alternatives representing a range of treatment combinations, as appropriate. The purpose of providing a range of alternatives is to ensure that all reasonable general remedial actions are represented and evaluated. The technologies that are selected to represent alternatives for free-product removal are presented in Table 5-2. The assembly of these technologies into alternatives for free-product removal are presented in Table 5-3.

TABLE 5-2

REPRESENTATIVE FREE-PRODUCT RECOVERY REMEDIAL ACTION TECHNOLOGIES

SITE 20, ALLEGHENY PIER (PIER 303)
NAS PENSACOLA, PENSACOLA, FLORIDA

General Remedial Action	Remedial Action Technology	Technology	Representative Technology
Institutional Controls	Access Restrictions	LUCs	LUCs
Monitoring	Free-Product Measurements	Free-Product Measurements	Free-Product Measurements
Removal	Free-Product Removal	Passive Skimming Water Table Depression AFVR	Passive Skimming Pneumatic Pumps Mobile Vacuum Truck

TABLE 5-3

ASSEMBLY OF FREE-PRODUCT REMOVAL ALTERNATIVES

**SITE 20, ALLEGHENY PIER (PIER 303)
NAS PENSACOLA, PENSACOLA, FLORIDA**

Alternative	Alternative Type	Representative Technologies Combined into Alternatives	Alternative Description
Alternative 1: Land Use Controls, Free-Product Removal by Passive Skimming, and Monitoring	Containment/Limited Action – No or limited treatment	LUCs, Passive Skimming, and Monitoring	▪ LUCs ▪ Skimming free product from 11 existing site monitoring wells using absorbent socks ▪ Periodic free-product measurements ▪ Posting of warning signs ▪ Five-year site reviews
Alternative 2: Land Use Controls, Free-Product Removal by Water Table Depression, and Monitoring	Containment/Limited Action – No or limited treatment	LUCs, Water Table Depression, and Monitoring	▪ LUCs ▪ Installation of extraction wells to remove free product and groundwater ▪ Treatment and disposal of groundwater ▪ Periodic free-product measurements ▪ Posting of warning signs ▪ Five-year site reviews
Alternative 3: Land Use Controls, Free-Product Removal by AFVR, Passive Skimming and Monitoring	Containment/Limited Action – No or limited treatment	LUCs, AFVR, Passive skimming, and Monitoring	▪ LUCs ▪ Installation of recovery wells ▪ Periodic AFVR vacuum events ▪ Passive skimming from 11 existing wells using absorbent socks ▪ Periodic free-product measurements ▪ Posting of warning signs ▪ Five-year site reviews

5.3 REMEDIAL ALTERNATIVES FOR FREE-PRODUCT REMOVAL

Three alternatives were developed to address free-product removal at Site 20. The alternatives are as follows and pertinent details of the alternatives are presented in Table 5-3.

Free-Product Removal Alternative 1: LUCs, Passive Skimming, and Monitoring
Free-Product Removal Alternative 2: LUCs, Water Table Depression, and Monitoring
Free-Product Removal Alternative 3: LUCs, AFVR, Passive Skimming, and Monitoring

5.3.1 Free-Product Removal Alternative No. 1: LUCs, Passive Skimming, and Monitoring

LUCs are rules, directives, policies, and other measures (e.g., preventing the usage of groundwater and drilling new wells, and posting signs) adopted by the appropriate authorities in a manner consistent with applicable Federal, state, and local laws. Land use at Site 20 is to remain industrial. LUCs would be implemented to ensure that access to the site is restricted during cleanup and to ensure appropriate future land use (e.g., restrictions on groundwater wells) once the remediation is complete.

Free product is present in 11 site monitoring wells ranging in thickness from 0.04 foot to 1.42 feet. Passive skimming systems do not actively pump free product; instead they slowly accumulate it over time by collecting free product that naturally flows to the passive skimmer devices. Absorbent socks are simple skimming devices that are suspended in the well across the surface of the free-product layer. Attached material absorbs product from the water surface and must be periodically removed and disposed. An absorbent sock skimming device would be placed in each of the 11 existing site monitoring wells for the removal of free product and in an additional 10 free-product recovery wells field located to intercept the free-product plume.

Monitoring consists of ensuring that LUCs remain in place, passive skimming is progressing, and that free-product measurements are performed periodically.

5.3.2 Free-Product Removal Alternative No. 2: LUCs, Water Table Depression, and Monitoring

Free-product removal alternative 2 would address free-product removal through groundwater extraction creating a cone of depression. Four extraction wells would be installed and equipped with pumps. Free product and groundwater would be recovered from the extraction wells by pumping. Groundwater would be treated and discharged to the POTW. LUCs would be implemented as described in Section 5.3.1. Monitoring for this alternative would involve ensuring that LUCs remain in place, that a cone of depression is created by pumping, and that periodic measurements of free-product thickness are performed.

5.3.3 Free-Product Removal Alternative No. 3: LUCs, AFVR, Passive Skimming, and Monitoring

This alternative combines the technologies of AFVR and absorbent socks for free-product removal. Four recovery wells would be installed for use during AFVR events. Proposed recovery well locations are shown on Figure 5-1. Experienced mobile vacuum contractors can connect to multiple wells simultaneously during an AFVR event. Absorbent socks would be placed in each of the 11 existing site monitoring wells that contain free product. LUCs and monitoring would be implemented as described in Section 5.3.1.

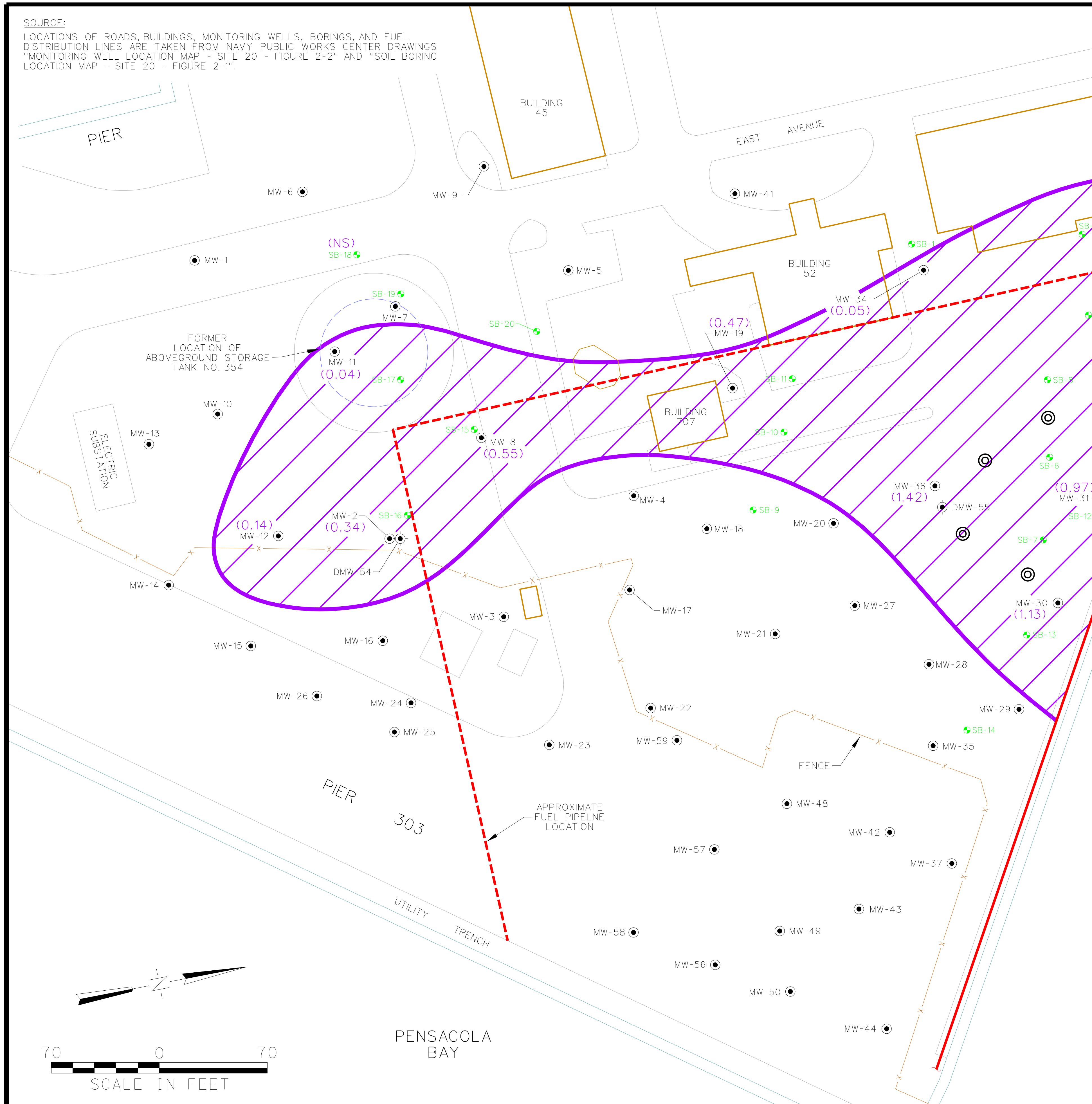


FIGURE 5-1

PROPOSED RECOVERY WELL LOCATIONS
SITE NO. 20
REMEDIAL ACTION PLAN

NAS PENSACOLA
PENSACOLA, FLORIDA

n11x17b.dgn

CAD FILE NO./DATE: k:\dgn\navy\pensacola\ 0401L\ 0401L011.dgn/10-25-01

5.4 EVALUATION OF REMEDIAL ACTION ALTERNATIVES

The identified remedial action alternatives are evaluated using the criteria in Chapter 62-770.700, F.A.C. The alternatives are evaluated against the standards listed below.

1. Long-term and short-term human health and environmental impacts.
2. Implementability, which may include ease of construction, site access, and necessity for permits.
3. Operation and maintenance (O&M) requirements.
4. Reliability.
5. Feasibility.
6. Estimated time to achieve cleanup.
7. Cost-effectiveness of installation, and operation and maintenance, when compared to other site remediation alternatives.

Long-term and Short-term Human Health and Environmental Impacts

Remedial action remedies must be protective of human health and the environment. Remedies may include those measures that are needed to be protective, but are not directly related to media cleanup, source control, or management of wastes. A discussion of what types of long-term and short-term remedies are appropriate for the site and how various remedial action measure alternatives meet this standard will be presented.

Implementability

Implementability will often be a determining variable in shaping remedies. Some technologies will require state or local approvals prior to construction, and there may be some restrictions or concerns for some remedial approaches. Typical factors to be considered include administrative activities (e.g., permits, right of way, off-site approvals) and the length of time these activities will take; constructability of the remedial measure and time for beneficial results; availability of off-site treatment, disposal, and storage facility services; and availability of prospective technology.

Operation and Maintenance Requirements

Some technologies will require excess or more complicated O&M than others. Typical factors to be considered include level of expertise of personnel required to maintain the system, routine maintenance frequency, ease of replacement of parts when needed, and availability of parts and labor.

Reliability

Demonstrated and expected reliability is a way of assessing the risk and effect of failure. It may be considered whether the technology or a combination of technologies have been used effectively under analogous site conditions, whether failure of any one technology in the alternative would have an immediate impact on receptors, and whether the alternative would have the flexibility to deal with uncontrollable changes at the site (e.g., heavy rain storms, earthquakes). Each remedial action measure alternative should be evaluated in terms of the projected useful life of the overall alternative and of its component technologies.

Feasibility

Only technologies with proven effectiveness in similar site conditions and contaminant concentrations are considered. The likelihood that the technology would be successful once implemented will be determined.

Estimated Time to Achieve Cleanup

The estimated time to achieve cleanup is a vital consideration. Many technologies will require decades to achieve remedial action goals. The time to achieve cleanup for each alternative will be estimated and evaluated in comparison with other acceptable alternatives.

Cost Effectiveness

The relative cost of a remedy may be an appropriate consideration, especially in those situations where several different technical alternatives to remediation will offer equivalent protection of human health and the environment. Cost estimates could include costs for engineering, site preparation, construction, materials, labor, sampling/analysis, waste management/disposal, permitting, health and safety measures, training, O&M, etc.

5.5 EVALUATION OF REMEDIAL ALTERNATIVES FOR FREE-PRODUCT REMOVAL

5.5.1 Free-Product Removal Alternative No. 1: LUCs, Passive Skimming, and Monitoring

Long-term and Short-term Human Health and Environmental Impacts

LUCs would effectively prevent direct human contact with contaminated groundwater by controlling site access and preventing the withdrawal of contaminated groundwater from the ground. Passive skimming would remove the floating free product and eliminate one source of contamination. Monitoring would assess the progress of passive skimming and make sure the restrictions on land use are in place, and monitor the progress of free-product removal and natural attenuation. Over a period of time the concentrations of COCs in groundwater would reach levels that are protective to human health and the environment.

Implementability

This alternative would be readily implementable. Materials and labor are readily available for installing absorbent socks. Monitoring requires periodic checking of each well for the progress of free-product skimming. Materials and labor required for monitoring are readily available. This alternative may require permits. Administrative issues and coordination with other agencies or acquiring permits are easily achievable.

Operation and Maintenance Requirements

O&M requirements for this alternative include site visits every 2 weeks during active remediation to check the condition of absorbent socks and to measure the thickness of free product and depth to water in all monitoring wells. The absorbent socks need to be removed, inspected, and replaced as necessary.

Reliability

The alternative is fairly reliable because skimming would indicate the presence and removal of a free-product layer.

Feasibility

Passive skimming using absorbent socks is feasible; however, free-product yields may be low increasing the time to achieve cleanup.

Estimated Time to Achieve Cleanup

Experience with passive skimming systems at sites with similar lithology and similar fuel oil contaminants indicates that adsorbed petroleum hydrocarbons within saturated zone soil continually leach into groundwater, prolonging remedial time periods. This leaching process cannot be predicted accurately. Therefore, an estimated remedial time period for the passive skimming system is 10 years.

Cost Effectiveness

The estimated capital cost of implementing Alternative 1 is $59,672. The annual O&M cost would be $21,870. Present worth cost over a period of 10 years would be $274,594. An estimated cost for installation of a passive skimming system and 10 years of operation is presented in Table 5-4 and Appendix C.

5.5.2 Free-Product Removal Alternative No. 2: LUCs, Water Table Depression, and Monitoring

Long-term and Short-term Human Health and Environmental Impacts

This alternative would remove free product from the saturated medium and would extract contaminated groundwater for treatment prior to disposal. Aspects of LUCs and monitoring are presented in Section 5.5.1. This alternative would provide a high degree of protection to human health and the environment because the source of contamination would be removed and contaminated groundwater would be treated.

Implementability

This alternative would be implementable. Extraction wells and treatment units could be readily installed. Limited manpower and materials are necessary to install collection and treatment systems. This alternative may require permits. Administrative issues and coordination with other agencies or acquiring permits are easily achievable.

Operation and Maintenance Requirements

This alternative involves mechanical equipment including pumps and treatment equipment that would require periodic maintenance and repair. Monitoring would require water level and free-product thickness measurements and treatment units would require sampling and laboratory analysis.

Reliability

Water table depression using extraction wells is a proven and established technology. The long-term reliability and effectiveness of the pump and treat system is proven. Once the system is properly designed and installed, the alternative would be reliable and effective.

TABLE 5-4

FREE-PRODUCT REMEDIAL ALTERNATIVES COST SUMMARY

SITE 20, ALLEGHENY PIER (PIER 303)
NAS PENSACOLA, PENSACOLA, FLORIDA

ALTERNATIVE	CAPITAL COST	ANNUAL O&M	ESTIMATED YEARS OF OPERATION	O&M PRESENT WORTH	TOTAL PRESENT WORTH
Passive Skimming	$59,672	$21,870	10	$214,922	$274,594
Free Product Recovery with Groundwater Depression	$66,452	$37,560	3	$80,304	$146,756
AFVR with absorbent socks	$63,496	$33,425	1	$33,425	$96,921

Note: See Appendix C for detailed cost estimates for the free-product remediation alternatives.

Feasibility

A properly designed water table depression system could be successful at free-product removal from the subsurface. However, the site is tidally influenced, making design to minimize drawdown more complicated.

Estimated Time to Achieve Cleanup

Operational time to remediation using groundwater depression was estimated at 3 years. An operational time of 3 years was used for cost purposes only, due to the uncertainties associated with the actual free-product concentrations that may be present. Actual removal times may vary significantly.

Cost Effectiveness

The estimated capital cost of implementing Alternative 2 is $66,452. The annual O&M cost would be $37,560. Present worth cost over a period of 3 years would be $146,756. A summary of costs is presented in Table 5-4 and detailed cost estimates are provided in Appendix C.

5.5.3 Free-Product Removal Alternative No. 3: LUCs, AFVR, Passive Skimming, and Monitoring

Long-term and Short-term Human Health and Environmental Impacts

This alternative would add AFVR to Alternative 1. Aspects of LUCs, passive skimming, and monitoring are presented in Section 5.5.1. Passive skimming and AFVR would the remove contaminant source in saturated medium. AFVR would aid aerobic biodegradation that would treat COCs in groundwater much faster than natural attenuation and would protect human health and the environment. This alternative does not require water to be pumped out of the ground. There would be no releases to air impacting human health or the environment. Free product collected through passive skimming and AFVR events would be disposed of following applicable standards and would not impact human health and the environment. LUCs would prevent access to contaminated water.

Implementability

This alternative would be readily implementable. Materials and labor are readily available for installing absorbent socks. Monitoring requires periodic checking of each well for the progress of free-product skimming. Materials and labor required for monitoring are readily available. Mobile vacuum contractors with experience in AFVR methods are available. This alternative may require permits. Administrative issues and coordination with other agencies or acquiring permits are easily achievable.

Operation and Maintenance Requirements

O&M requirements for this alternative include site visits every 2 weeks during active remediation to check the condition of absorbent socks and to measure the thickness of free product and depth to water in all monitoring wells. The absorbent socks need to be removed, inspected, and replaced as necessary.

Reliability

Dual-phase extraction is a reliable and proven technology. The use of mobile vacuum trucks rather than permanent treatment systems has also proven to be a reliable and cost-effective alternative.

Feasibility

Vacuum extraction of free product using AFVR is likely to be successful in removing free product from the subsurface while promoting aerobic biodegradation. Passive skimming is intended to remove relatively low volume thickness of free product as the devices are designed to do.

Estimated Time to Achieve Cleanup

Based on the use of AFVR at similar sites in Florida and moderate free-product levels, it is estimated that free-product recovery may be achieved with six or fewer AFVR events. The time duration of this remedial technology was estimated at 12 months.

Cost Effectiveness

The estimated capital cost of implementing Alternative 3 is $63,496. The annual O&M cost would be $33,425. Present worth cost over a period of 1 year would be $96,921. A summary of costs is presented in Table 5-4 and detailed cost estimates are provided in Appendix C.

5.6 RECOMMENDATION OF FREE-PRODUCT REMOVAL REMEDIAL ACTION

The goal of the remedial system is to remove free product from the site. The free-product plume at the site was estimated at 102,000 square feet, with a total volume of 5,700 gallons.

The primary advantage of using a passive skimmer system is the low capital cost. The disadvantage with passive skimming systems is that only free product that naturally comes in contact with the skimming device is collected.

The primary advantages of free-product recovery with water table depression are the shorter duration compared to passive skimming and it treats both free product and contaminants in groundwater. The main disadvantage with water table depression is that the technique causes a smear zone of free product. Additionally, the free product has a high viscosity and will take longer to remove than most free-product plumes. The high viscosity free product will result in a prolonged remedial time and large quantities of groundwater that require treatment and disposal. This alternative is eliminated from further consideration due to these concerns, higher costs, and permitting associated with discharging the generated water.

The primary advantage of AFVR is that there is no permanent treatment system required, resulting in much lower capital and O&M costs. AFVR also makes disposal of extracted free product and groundwater uncomplicated because the recovered material is extracted into a mobile vacuum truck. A comparison of the estimated cost of removing free product using each evaluated alternative is provided in Table 5-4. Based on a review of the advantages, disadvantages, and costs, the preferred alternative is AFVR in conjunction with absorbent socks to remediate the free product at this site.

Past uses of AFVR have provided a high degree of overall protection to human health and the environment by providing quick reductions of free-product volumes. AFVR will promote in situ biodegradation and volatilization of hydrocarbon constituents within the soil matrix. The equipment and controls needed for AFVR are reliable, easily operated, and commonly available; and systems typically require low capital and minimal O&M cost. Minimal permitting may be required for the implementation and operation of AFVR. Similar to other vapor extraction technologies, AFVR is most effective when free-product plumes are located under paved or sealed surfaces, which reduces the possibility of “short circuiting” the high vacuum pressure. The area where AFVR would be performed is covered with asphalt and concrete and the water table ranges from approximately 5 to 11 feet bls. These conditions are most conducive to successful AFVR events.

The use of AFVR is a preferred alternative based on (1) low capital and O&M costs, (2) low impact on surrounding site conditions, (3) proven effectiveness, and (4) the expectation that AFVR will also provide a shorter duration to achieve cleanup standards and goals compared to the other alternatives. Table 5-5 summarizes the advantages and disadvantages of each remedial alternative.

TABLE 5-5

SUMMARY OF REMEDIAL ALTERNATIVES

**SITE 20, ALLEGHENY PIER (PIER 303)
NAS PENSACOLA, PENSACOLA, FLORIDA**

Alternative	Advantages	Disadvantages
Alternative No. 1: LUCs, Passive Skimming, and Monitoring	▪ Focused on free product ▪ Low capital costs ▪ Small disposal quantities	▪ Not active ▪ Longer time duration
Alternative No. 2: LUCs, Water Table Depression, and Monitoring	▪ Controls dissolved plume ▪ Large radius of influence	▪ High capital costs ▪ Requires continuous water treatment and disposal ▪ On-site system required ▪ Groundwater depressed which smears the free product
Alternative No. 3: LUCs, AFVR, Passive Skimming, and Monitoring	▪ Low O&M and capital costs ▪ Permanent system installation not required ▪ Large radius of influence ▪ Vapor phase and mobile free product removed simultaneously	▪ Disposal of removed product and groundwater ▪ Multiple events required

5.7 IDENTIFICATION AND SCREENING OF GROUNDWATER REMEDIAL TECHNOLOGIES

Based on the SAR and SARA data, the total volume of groundwater contaminant concentrations in excess of FDEP GCTLs is approximately 4 million gallons. The following technologies were identified for remediation of groundwater and were screened:

- Natural Attenuation
- In Situ Bioremediation
- Pump and Treat

The following technologies were eliminated based on effectiveness concerns:

- In situ bioremediation was eliminated from further screening because lead is not readily biodegradable. Once lead is removed, an in situ bioremediation technology may prove effective in remediating the site.

- Natural attenuation was eliminated from further screening because it would not be protective of human health and the environment at this time. Once free product and lead are removed, monitored natural attenuation may prove effective.

5.7.1 Groundwater Pump and Treat

Pump and treat is one of the most widely used groundwater remediation technologies. Conventional pump and treat methods involve pumping contaminated groundwater to the surface for treatment. Variations and enhancements of conventional pump and treat include hydraulic fracturing as well as chemical and biological enhancements. Pump and treat systems are used primarily to accomplish hydraulic containment—to control the movement of contaminated groundwater, preventing the expansion of the contaminated groundwater zone and/or treatment—to reduce the dissolved contaminant concentrations in groundwater sufficiently that the aquifer complies with cleanup standards.

5.7.2 Groundwater Extraction, Treatment, and Discharge

Remediation for Site 20 will consist of a phased approach. Initial remedial actions will focus on free-product removal as described previously. Concurrent with aggressive free-product recovery efforts, groundwater extraction will be implemented on a limited basis. Although the intention is to implement groundwater recovery only in areas absent of free product, the possibility exists for free product to be recovered with extracted groundwater. Therefore, an oil/water separator will be required for phase separation. Once separated, free product would be collected for removal and disposal. The remaining liquid could require additional treatment prior to discharge. Other options for phase separation, such as dissolved air flotation, are considerably higher in capital and O&M costs and normally are only used under special conditions.

Hydrocarbon Treatment

Granular activated carbon (GAC) adsorption has been used successfully for the treatment of gasoline and kerosene range fuel contaminated groundwater. Adsorption occurs when molecules adhere to the internal walls of pores in carbon particles produced by thermal activation. Extracted groundwater would be pumped to an equalization tank from which it would be pumped through a carbon column.

Pre-treatment for iron may be needed to prevent plugging of the column. The activated carbon would adsorb naphthalene and TRPH compounds from water.

Lead Treatment

Ex situ groundwater treatment for lead can be accomplished by ion exchange, chemical precipitation, and specialized media adsorption/absorption. These options are discussed further below. Specialized media are typically required for lead concentrations significantly higher than those present at Site 20.

Ion Exchange

Ion exchange is a process in which ions held by electrostatic forces on the surface of a porous solid are exchanged for ions similar in charge in a solution in which the porous solid is immersed. By this means specific constituents can be removed from a solution that contains multiple constituents. Exchange is accomplished by passing the solution through porous solid materials, usually minerals of the zeolite group or specially prepared synthetic resins (plastics) containing large complex molecules. Certain ions in the solution replace ions or groups of ions in the resin or zeolite from which they can then be washed out. By controlling the acidity, strength, and composition of the solution and the nature of the resin, ions in solution are selectively exchanged for the exchangeable ions that are in the resin. Ion exchange media must be periodically regenerated. Regeneration requires a backwash subsystem and creates a sludge that requires handling and disposal.

Ion exchange units can be designed to remove 99 percent of selected ionic contaminants. Due to the low extraction rate and the relatively low contaminant concentrations expected, the cost for ion exchange is considered moderately high.

Chemical Precipitation

Groundwater treatment with chemical precipitation involves the addition of chemicals to alter the physical state of dissolved and suspended solids and facilitate their removal. Sedimentation and filtration are then used to remove precipitated particles. Chemical precipitation requires the addition of a coagulating agent and creates significant sludge that requires additional handling and disposal. Chemical precipitation capital and O&M costs are high. Therefore, chemical precipitation is eliminated from further consideration based on high cost.

5.7.3 Groundwater Extraction and Discharge

The discharge options screened below are effective for the discharge of extracted groundwater.

Discharge to POTW or Base IWTP

Discharge to an existing sewer system (POTW or Base industrial waste treatment plant) consists of pretreatment and transference to an existing sewer system. The Escambia County Utilities Authority (ECUA) now accepts wastewater from NAS Pensacola. A discussion with the ECUA Coordinator of Pretreatment indicated that extracted groundwater with free product removed would be acceptable without further pretreatment. In addition, permitting issues should be minor. The cost of connecting to the existing sewer system will require a capital investment for a dedicated force main from the site to an existing force main at NAS Pensacola's north boundary. Costs from discharge fees would be a regular expense based on flow rate and are considered moderate.

Discharge to Surface Water

Treated groundwater could be discharged to the surface at the site. Surface discharge would require on-site treatment to acceptable levels for a National Pollutant Discharge Elimination System (NPDES) permit. Additionally, groundwater laboratory analysis would be required to demonstrate compliance with the permit. Surface discharge normally involves low capital investment and O&M costs.

5.8 DEVELOPMENT OF GROUNDWATER REMEDIAL ALTERNATIVES

The technologies that passed the preliminary screening are selected to represent a typical general remedial action and are assembled into alternatives representing a range of treatment combinations, as appropriate. The purpose of providing a range of alternatives is to ensure that all reasonable general remedial actions are represented and evaluated. The technologies that are selected to represent alternatives for groundwater remediation are presented in Table 5-6. The assembly of these technologies into alternatives for groundwater remediation are presented in Table 5-7.

TABLE 5-6

REPRESENTATIVE GROUNDWATER REMEDIAL ACTION TECHNOLOGIES

SITE 20, ALLEGHENY PIER (PIER 303)
NAS PENSACOLA, PENSACOLA, FLORIDA

General Remedial Action	Remedial Action Technology	Technology	Representative Technology
Natural Attenuation	Natural Attenuation	Natural Attenuation	Groundwater Monitoring
In Situ Bioremediation	In Situ Bioremediation	ORC® Injection	DPT to inject ORC
Pump and Treat	Groundwater Extraction	Groundwater Extraction	Groundwater Extraction using recovery wells

TABLE 5-7

ASSEMBLY OF GROUNDWATER REMEDIAL ALTERNATIVES

**SITE 20, ALLEGHENY PIER (PIER 303)
NAS PENSACOLA, PENSACOLA, FLORIDA**

Alternative	Alternative Type	Representative Technologies Combined into Alternatives	Alternative Description
Alternative 1: Groundwater Extraction, Oil/Water Separation with Discharge to POTW	Pump and Treat	Groundwater Extraction with pretreatment	▪ Installation of recovery wells ▪ Installation of in-well pumps and piping system ▪ Installation of oil/water separator ▪ Connection to existing POTW ▪ Periodic groundwater monitoring ▪ Five-year site review
Alternative 2: Groundwater Extraction, Treatment with Discharge to Surface Water	Pump and Treat	Groundwater Extraction with on-site treatment	▪ Installation of recovery wells ▪ Installation of in-well pumps and piping system ▪ Installation of on-site groundwater treatment system ▪ Obtain NPDES permit ▪ Periodic groundwater monitoring ▪ System O&M ▪ Five-year site review

The remedial technology options for groundwater remediation have been identified and screened based on effectiveness, implementability, and cost. A summary of reasons for retention or elimination of technology options is presented in Table 5-1. Based on the screening results, two alternatives for groundwater remediation exist.

5.8.1 Groundwater Alternative No. 1: Groundwater Extraction, Oil/Water Separator with Discharge to POTW

Groundwater Alternative No. 1 consists of groundwater remediation by groundwater extraction with oil/water separator pretreatment and discharge to a POTW. The pretreatment will include phase separation in an oil/water separator. Separated free product will be collected and taken off-site for disposal.

This alternative would involve the installation of a minimum of ten groundwater extraction wells. The locations of the wells will be field determined following a comprehensive groundwater monitoring event to evaluate current groundwater contamination. Five years of natural attenuation monitoring would follow active groundwater remediation.

5.8.2 Groundwater Alternative No. 2: Groundwater Extraction and Treatment With Discharge to Surface Water

This alternative would consist of the installation of a minimum of 10 groundwater extraction wells, each equipped with a pump for the extraction of contaminated groundwater. Groundwater would be treated on-site with phase separation, TRPH removal with GAC, and lead removal with ion exchange. Separated free product would be collected and taken off-site for disposal. Five years of natural attenuation monitoring would follow active groundwater remediation.

5.9 EVALUATION OF REMEDIAL ALTERNATIVES FOR GROUNDWATER

Long-term and Short-term Human Health and Environmental Impacts

Both alternatives would reduce long-term human health and environmental impacts by the use of free product and treatment of contaminated groundwater from the subsurface at Site 20. Short-term impacts could be minimized by eliminating contact with contaminants through engineering controls and proper handling and disposal of residuals produced during construction and O&M. However, disposal of extracted groundwater to the POTW would provide more protection because discharge to the surface could potentially create exposure risks.

Implementability

Both alternatives are implementable with utilities available in reasonable proximity to the site, including potable water, electricity, communications, and sewer. However, discharge to the POTW would be more easily implemented because the treatment system would be much less extensive and no NPDES permit would be required.

O&M Requirements

Groundwater Alternative No. 2 would have substantially higher O&M requirements for GAC and ion exchange. Groundwater Alternative No. 2's increased complexity would increase downtime for routine O&M, optimization, and nonpreventable malfunction. Ion exchange media regeneration and sludge handling constitute the majority of this increased effort.

Reliability

Both systems consist of conventional components with proven reliability if they are operated and maintained properly. Groundwater Alternative No. 2 is the more complex system; therefore, it would be less reliable than Groundwater Alternative No. 1, due to increased downtime for routine maintenance and nonpreventable malfunction.

Feasibility

Both alternatives are technically feasible. The expertise for design, construction, and operation is regionally (if not locally) available. All components are conventional "off-the-shelf" equipment, readily available from multiple vendors.

Estimated Time to Achieve Cleanup

Both alternatives would have the same duration of operation because the basic remedial processes for the extraction of groundwater are the same. The alternatives only differ in the level of treatment and the discharge option. The estimated time to achieve cleanup is 11 years of active groundwater remediation followed by 5 years of natural attenuation monitoring.

Cost

Detailed cost estimates for both alternatives are presented in Appendix C. The estimated present worth costs for Groundwater Alternatives No. 1 and No. 2 are $1,335,399 and $1,535,282, respectively. The differential in cost consists of Groundwater Alternative 2's higher capital and O&M costs.

5.10 RECOMMENDATION OF GROUNDWATER REMEDIAL ACTION

Groundwater Alternative No. 1, Groundwater Remediation with discharge to POTW is the preferred alternative based on: (1) more protective of human health and the environment, (2) more easily implementable, (3) less complicated system making the alternative more reliable and less O&M intensive, and (4) lower cost.

6.0 REMEDIAL SYSTEM DESIGN

Remediation for Site 20 will involve a phased approach. Initial remedial activities will focus on free-product removal followed by groundwater remediation. Limited groundwater collection may be implemented outside of the free-product plume during free-product recovery activities. The preferred remedial alternatives for free-product removal and groundwater remediation presented in this RAP were selected based on low capital and O&M costs, low impact on surrounding site conditions, proven effectiveness, and time to achieve cleanup. The potential remedial technologies and process options for free-product removal and groundwater remediation were identified and screened, and the results were presented in Section 5.0. The selected alternative for free-product removal is dual-phase extraction by AFVR in conjunction with placement of absorbent socks in site monitoring wells. The selected alternative for groundwater remediation is groundwater extraction by pump and treat with discharge to the POTW.

6.1 BASIS OF DESIGN

The following design is based on the findings of the preceding sections and assumptions made from literature and engineering judgment. A summary of design criteria follows.

6.1.1 Design Information

- The selected alternative for free-product removal is dual phase extraction by AFVR in conjunction with placement of absorbent socks in site monitoring wells. The selected alternative for groundwater remediation is groundwater extraction by pump and treat with discharge to the POTW.
- Groundwater remediation is required for TRPH and total lead.
- The free-product volume is estimated to be 5,700 gallons.
- Contaminated groundwater volume is estimated to be 3,948,318 gallons.
- A reduction of groundwater concentrations for the COCs below GCTLs is required.
- Liquids extracted during pump and treat operations will be pretreated with phase separation and discharged to the POTW.

6.1.2 Assumptions

- A reasonable and technically feasible goal for free-product recovery is six AFVR events.
- A maximum of 50 percent of the free product is recoverable.

6.2 TECHNOLOGY DESCRIPTION AND SYSTEM DESIGN

Major components of the selected remedial alternative will include the following:

- Pre-design engineering data
- Free-product recovery
- Groundwater remediation
- Remedial system O&M
- Remedial system termination criteria
- Site restoration

6.2.1 Collection of Engineering Design Data

An additional round of groundwater sampling and analysis will be performed in accordance with Chapter 62-770.700(3)(c), F.A.C., because the analyses in the SARA are more than 270 days old. A comprehensive sampling round is recommended for predesign evaluation of current site conditions.

6.2.2 General Requirements Prior to the Beginning of Construction Activities

- A utility clearance will be required.
- All operators must be certified to be in compliance with 29 *Code of Federal Regulations* 1910.120 health and safety requirements.
- The locations of the groundwater collection wells, the routes of the collection piping, and the limits of the pretreatment plant and related areas will be surveyed and staked in the field.
- The contractor will prepare all required planning documents, such as an Erosion and Sediment Control Plan, Health and Safety Plan, Removal Action Plan, and Waste Management Plan and also obtain all necessary permits.
- Erosion and sediment controls will be implemented prior to and during site activities.

6.2.3 Recovery System Description

The conceptual groundwater collection system will consist of ten 4-inch-diameter polyvinyl chloride extraction wells placed at depths from 15 to 25 feet. The locations of the wells will be field determined after evaluation of predesign groundwater analytical data. The wells will have 10-foot screen lengths positioned to intercept the water table.

The extracted fluid will be collected by a system of underground pipelines and transferred to an oil/water separator. All collection and manifold piping will be 2-inch- or 4-inch-diameter polyvinyl chloride Schedule 40 pipe. The collection piping trench backfill will be placed in 12-inch lifts and compacted to 90 percent Modified Proctor Density. The separated extracted groundwater will be transferred to the POTW. The collected free product will periodically be removed from the oil/water separator and disposed.

6.3 AFVR DESIGN

6.3.1 Design Specification

AFVR is a technology that is used for rapid recovery of free product and is often the most cost-effective approach for product recovery (NCDENR, 1998). AFVR uses a vacuum to recover both fluids (groundwater/free product) and vapor-phase hydrocarbons from monitoring/recovery wells. AFVR uses vacuum trucks that will generate high vacuum and airflow rates.

The application of AFVR for the site was chosen based on knowledge of site lithology and soil permeability and based on AFVR applications at other sites with similar soil conditions. Based on discussions with AFVR vendors and the use of this technology at other sites in Florida, it is expected that six AFVR events will remove free product from the site. AFVR guidance material indicates that each AFVR event should be performed for 8 to 12 hours, or until the vacuum truck is full.

The vacuum truck should meet the following specifications. These specifications are taken from the North Carolina Department of Environment and Natural Resources (NCDENR) guidance, due to the absence of FDEP guidance, and have been accepted by the FDEP at other sites:

- The vacuum truck tank should have a minimum storage capacity of 2,000 gallons.

- The vacuum tank should meet all requirements of Section VII Division 1 of the American Society of Mechanical Engineers Boiler and Pressure Vessel Code. Design pressure should be 25 pounds per square inch and registered with the National Board. The tank should be designed and constructed in full compliance with Department of Transportation (DOT) Specification DOT 407/DOT 412.

- The vacuum pump or blower shall be capable of running continuously for 8 to 12 hours without overheating.

- The pump or blower of the vacuum truck shall be capable of operating continuously at vacuum pressures between 24 and 27 inches of mercury (Hg) and the airflow at those vacuum pressures shall be at least 400 cfm (i.e., 400 cfm @ 24 inches of Hg). “Free Air” specifications shall not be accepted. High vacuum pressures increase recovery of hydrocarbons. High flow rates (cfm) will likely result in quicker recovery of free product and fewer site visits. Request pump curves for the vacuum truck (preferably from the pump manufacturer) to verify capacity.

- According to the American Petroleum Institute’s (API) Publication 2219*, Safe Operating Guidelines for Vacuum Trucks in Petroleum Service* (1986), it is stated that “pneumatic-conveyor (blower) equipment operates on a high-airflow principle and is not suitable for hydrocarbon service.” It is strongly recommended that the safety guidelines presented in the API Publication 2219 are followed. Examples of some of these safety measures include placing the exhaust stack downwind from the truck as far as practicable and ensuring that the gases do not accumulate in a confined space or in any area that has the potential for auto-ignition. It is also recommended that the exhaust stack be elevated to enhance the dispersion of emissions.

- Each AFVR event shall be conducted for an 8- to 12-hour period or until the vacuum truck tank is full of product and groundwater. The vacuum truck shall be equipped with a 4- or 6-inch-diameter recovery hose, which is connected to the recovery wells. The recovery wells should be a minimum of 4-inch-diameter wells specifically designed for free-product recovery. The 1- to 1.5-inch Stinger pipe with the inlet shall be placed inside each recovery well positioned approximately 12 inches below the static water level. The Stinger pipe shall then be sealed to the well head to prevent vacuum loss.

6.3.2 Treatment Recovered Liquids

All free product and water recovered from the location shall be stored in the tank of the vacuum truck. After completion of each event, the Subcontractor shall be responsible for disposing of the waste at an appropriate licensed location with prior approval from the Navy.

6.4 AFVR ACTIVITIES

The primary goal of AFVR is to rapidly remove free product from the groundwater and capillary fringe. The thickness of free product in each well will be measured before the initial recovery event. After the recovery event, the amount of free product will be measured. Recovery events shall continue if the free-product removal is determined to be effective. Based on free-product estimates, similar experience in Florida, and discussions with vendors, the number of recovery events is estimated at six or less. Free-product thickness measurements and vapor measurements shall be obtained during AFVR activities. In general, the following apply.

- Because of high vacuum pressures, an actual increase in product thickness may occur after the first event. This is not unusual because the vacuum causes water, product, and air to the vacuum wells. Each AFVR event shall be performed as long as possible (8 or more hours per event) in order to maximize effectiveness.

- The radius of influence assumed for this RAP is 50 feet, but the water levels and vacuum pressures in nearby wells will determine this when measured during the first AFVR event. This information may also be useful for system optimization.

AFVR events require the following measurement and actions to be performed.

- When the AFVR truck arrives on-site, a safety check of all equipment shall be performed. The vacuum truck tank shall be inspected to verify that the tank is free of any residual petroleum.

- Prior to the AFVR event, free product and groundwater measurements shall be obtained from the proposed recovery wells and all other wells at the site.

- Install AFVR to recovery wells and begin operation.

- During the AFVR operation the parameters listed below shall be collected at 15-minute intervals for the first 2 hours, and at 30-minute intervals thereafter.

    - Vacuum pressures on blower or pump and on nearby wells (non-AFVR wells).

    - Water levels and free-product measurements at nearby wells (non-AFVR wells).

    - Use an Anemometer or Pitot Tube to collect air velocity rates from the center of the stack or discharge outlet.

    - Temperature from the stack or discharge outlet.

    - Use an OVA-FID to measure the TRPH concentrations (ppm) from the stack or discharge outlet and provide the inside diameter dimension of the stack. An FID that has a range of 0-10,000 ppm or an FID with a range of 0-100,000 ppm is an approved instrument for determining TRPH concentrations. Do not use a photoionization detector (PID). When recovering high boiling point hydrocarbons (e.g., heating oil), expect low TRPH concentrations from the discharge stack of the truck.

- After the completion of the event, free product and groundwater measurements shall be collected from the AFVR wells, and the volume of free product recovered in the vacuum truck tank shall also be determined.

- Disconnect system and demobilize.

- Measure for the presence of free product in all wells 2 weeks after the AFVR event. If free product is present in wells at the site, schedule another AFVR event. If free product is not present in any well after the 2-week measurement, continue to measure for free product every 2 weeks until 2 months have passed since the day of the AFVR event. If no free product is present at this time, post-active remediation monitoring shall be implemented.

- The above measurements (velocity, temperature, TRPH concentrations, and diameter of stack) will be used to calculate a mass vapor-phase removal rate [pounds per hour (lb/hr)] by using the equations below. From the emission calculations, convert the units from pounds to gallons removed. To arrive at a total gallons removed, add the gallons (from emission calculation) to the total gallons of free product measured in the tank of the vacuum truck. All measurements and calculations for each event shall be incorporated into a "Free Product Recovery Status Letter." The equations necessary for the vapor-phase mass removal rates are:

<u>Equation to Determine Flow as Dry Standard Cubic Feet Per Minute (DSCFM):</u>

$B_{ws} = (B_{wsw}/18 \text{ lb-mole } H_2O)/\ [1/28.84 \text{ lb-mole dry air}) + (B_{wsw}/18 \text{ lb-mole } H_2O)]$

$Q_{std} = (60 \text{ sec/min})\ (1\text{-}B_{ws})\ (V)\ (A)\ (528\ R^o / T_s)$

Where:

Q_{std} = flow at DSCFM
B_{wsw} = lb of water per lb of dry air (use high temperature psychrometric chart for air-water vapor mixtures in *Perry's Chemical Engineers' Handbook*, 1984)
B_{ws} = water vapor % by volume
V = velocity in ft/sec [obtain with hot wire anemometer or pitot tube (use average value)]
A = cross sectional area of discharge stack in sq. ft. at sampling location
T_s = stack temperature in degrees Rankin (R^o), R^o = degrees Fahrenheit (F^o) + 460 (use average value)

Equations to determine Vapor Phase Mass Removal rate (PMR_h):

$ppm_w = ppm_{measured}$

$ppm_d = (ppm_w) / (1-B_{ws})$

$ppm_c = (ppm_d) (K)$

$C_{c:m} = ppm_c (M_c/K_3)$

$C_c = C_{c:m} (62.43x10^{-9}$ lb-m^3/mg-ft^3)

$PMR_c = C_c$ (Qstd) (60 min/hr)

$PMR_h = (PMR_c) (M_h/M_{ch})$

Where:

ppm_w = "wet" concentration

$ppm_{measured}$ = obtained directly from OVA (use average value)

ppm_d = "dry" concentration

K = number of carbons in calibration gas (methane K=1, propane K=3, hexane K=6)

$ppm_c = ppm_v$, volumetric concentration of VOC emissions as carbon, dry basis, at standard temperature and pressure (STP)

$C_{c:m}$ = mg/dsm^3, mass concentration of VOC emissions as carbon

M_c = 12.01 mg/mg-mole, molecular weight of carbon

K_3 = 24.07 dsm^3/10^6 mg-mole, mass to volume conversion factor at STP

C_c = lb/dscf, mass concentration of VOC emissions as carbon, dry basis, at STP

PMR_c = lb/hr, pollutant mass removal rate of VOCs as carbon

PMR_h = lg/hr, pollutant mass removal rate of VOCs as heating oil

M_h = mg/mg-mole, molecular weight of heating oil

M_{ch} = mg/mg-mole, weight of carbon in heating oil molecule

6.5 ABSORBENT SOCKS

Absorbent socks are simple skimming devices that are suspended in the well across the surface of the free-product layer. Attached material absorbs free product from the water surface and must be periodically removed and disposed.

The primary goal of the absorbent socks is to recover free product from those wells where product thickness is relatively low. Absorbent socks will be placed in monitoring wells that have historically contained measurable free product (MW-2, MW-8, MW-11, MW-12, MW-19, MW-30 through MW-34, and MW-36).

6.6 GROUNDWATER REMEDIATION

A phased approach will be used for site remediation. The first phase will consist of free-product recovery. Because groundwater will be co-extracted as a by-product during free-product recovery, some groundwater remediation will be accomplished in the first phase. In the second phase, following the termination of free-product recovery, natural attenuation as a groundwater remediation option will be re-assessed according to data collected during and following free-product recovery. If natural attenuation is still not a viable option, the free-product recovery system will be converted to a groundwater pump and treat system. The pump and treat system will be operated until the site data demonstrate that natural attenuation is a viable remedial option.

In an effort to decrease active remediation time, select wells outside the horizontal extent of the free-product layer will be included to extract groundwater from areas of high lead concentrations for treatment during the first phase of site remediation. Submersible pumps will be used to extract groundwater from these wells. Extraction rates from these wells will be low to prevent their influence on the adjacent free-product layer.

6.7 ROUTINE REMEDIAL SYSTEM OPERATION AND MAINTENANCE

The proposed remedial system is designed to operate continually and automatically with minimal maintenance. Site visits for system inspection and maintenance will be performed by a trained and qualified technician in conjunction with regularly scheduled sampling events. The following inspection and maintenance items are scheduled to be performed daily for the first week and biweekly thereafter.

- Inspect system area for signs of trespassing/tampering, weather damage, deterioration, unusual noises, temperature, fire extinguisher charge, and general cleanliness.
- Inspect all signs and markings for condition and legibility.
- Inspect extraction wells and measure flow.
- Inspect and replace any gauge, valve, or sensor found to be leaking or inoperable.
- Inspect oil/water separator and remove and dispose of accumulated free product. Record volume of free product recovered.
- Record run time meter readings, groundwater discharge flow rate, and total gallons of water discharged.
- Log all inspection activities and repairs performed.

6.8 REMEDIAL SYSTEM TERMINATION CRITERIA

Groundwater pump and treat will terminate when site contaminant concentrations meet the natural attenuation criteria in Chapter 62-770.690 F.A.C. Natural attenuation monitoring will then be performed according to Chapter 62-770-690(7) F.A.C.

6.9 SITE RESTORATION

Following completion of remediation, the extraction wells will be abandoned, the collection piping removed, the oil/water separator salvaged, and site utilities capped or removed.

7.0 MONITORING PLAN AND PROJECT CLOSEOUT

The Monitoring Plan contains procedures for system implementation, routine O&M between AFVR events, and final reporting and monitoring after the completion.

7.1 MONITORING FREE-PRODUCT REMEDIATION PROGRESS

The performance monitoring program will be evaluated after each AFVR event and will be modified as necessary to maximize the effectiveness of the remediation. During AFVR events, three phases of petroleum will be removed: the free product, the dissolved phase contained in the groundwater, and the vapor phase, which is discharged in the exhaust. The following monitoring requirements will be performed during each AFVR event.

- Hydrocarbon mass. The mass rate of hydrocarbons removed by the AFVR system in comparison with the estimated mass present.

- Free product in recovery wells. The free-product thickness will be measured immediately after the AFVR event and again 2 weeks later. If free product is present at that time, the next AFVR event shall be scheduled. The AFVR events shall be scheduled at an interval to allow for free-product monitoring after 2 weeks and to allow submission of status reports, to determine if an additional AFVR event is necessary.

- Free product and groundwater elevations. The thickness of free product and water and product elevations will be measured in all monitoring wells. The absorbent socks will be removed, inspected, and replaced as necessary. Water and free-product measurements will be taken every 2 weeks during active remediation.

- Free-product skimming. Free-product skimming using absorbent socks should be continued until it is no longer recovering significant amounts of hydrocarbons (e.g., less than 2 gallons per month).

- Free-product thickness trend. If the trend in free-product thickness indicates the technology is effective in remediating the area, the additional events shall be performed. If after the second AFVR event the AFVR events are determined to be unsuccessful, then the AFVR events shall be discontinued and modification or an alternate approach shall be considered.

Monitoring data will be used to determine if the objectives of the RAP and standards of the design criteria are being met (i.e., free-product thickness is less than 0.01 foot). After each AFVR event a brief status letter shall be submitted providing the information stated in Section 6.0 and recommendations. The status letters are discussed in further detail in subsection 7.5. The remediation will be modified if the monitoring data indicate that the cleanup goals can be met earlier or cannot be met in the time frame as specified in the RAP. Modifications of the remedial action will be based on the site-specific monitoring data.

7.2 FREE-PRODUCT REMEDIATION COMPLETION

If the AFVR events are successful in removing the free product from the site to less than 0.01 foot, and absorbent socks are no longer skimming a significant amount of product, then the socks will be removed from the wells and the post-active remediation monitoring in Chapter 62-770.750, F.A.C. shall be implemented. Water level and free-product thickness will continue to be measured quarterly for 12 months following the suspension of active remediation. A threshold level of hydrocarbon thickness of 0.1 foot will be used as an action level to restart free-product recovery.

7.3 MONITORING GROUNDWATER REMEDIATION PROGRESS

A system- and site-monitoring program will be initiated upon approval of this RAP and subsequent to the completion of remedial activities. The monitoring plan has the following three main objectives:

- Monitor the overall effectiveness of remedial activities in reducing free-product volume and groundwater contaminant concentrations.
- Verify that the contaminant plumes have not migrated beyond current boundaries.
- Comply with Chapter 62-770, F.A.C.

7.4 SYSTEM AND SITE MONITORING

The final selection of monitoring wells will be based on pre-design and construction data. Initial system start-up and testing will incorporate the requirements below, but will be performed daily for the first 3 days with a 24-hour analysis turnaround, then monthly for 2 months, quarterly for the first year, and semiannually thereafter.

- The groundwater collection system's 10 extraction wells will be monitored on a quarterly basis for groundwater elevation and extraction rates.

- Measurements of groundwater levels in the groundwater extraction wells and selected monitoring wells will determine groundwater flow on a quarterly basis.

- Sampling and laboratory testing of groundwater from groundwater extraction wells and selected monitoring wells (to document remediation progress) will be performed quarterly for the first 2 years and semiannually thereafter. Groundwater analysis will be determined based on the results of the initial comprehensive groundwater sampling events. However, unless site contaminant concentrations change significantly from available data, the following is expected to be required. Groundwater samples will be analyzed for gasoline and kerosene range hydrocarbons, TRPH, and total lead. Dissolved oxygen (DO), oxygen reduction potential (ORP), pH, temperature, conductivity, and turbidity will also be measured. Preliminary analyses will include total suspended solids, total dissolved solids, iron, and hardness. It is recommended that the initial comprehensive groundwater monitoring event include natural attenuation parameters to determine a baseline for future comparison once monitored natural attenuation is implemented.

- Samples will be collected from selected groundwater monitoring wells for natural attenuation parameters. These samples will be analyzed for DO, ORP, nitrate, sulfate, methane, and ferrous iron, and any other constituents required for the natural attenuation evaluation.

- Additional monitoring and analyses will be performed as needed for system optimization.

If COCs do not exceed the background concentrations or the applicable GCTLs in samples from the groundwater extraction wells or monitoring wells for three consecutive quarters, these wells may be excluded from subsequent monitoring events, per Chapter 62-770.700(3)4(h), F.A.C. The requirements of the proposed monitoring plan are summarized in Table 7-1.

TABLE 7-1

GROUNDWATER REMEDIAL ACTION MONITORING SUMMARY

SITE 20, ALLEGHENY PIER (PIER 303)
NAS PENSACOLA, PENSACOLA, FLORIDA

Monitoring/Sample Location	Parameters	Frequency/Reporting
Groundwater monitoring for natural attenuation	NO_3, SO_4, CH_4, and Fe^{2+}	Pre-design and following active remediation
Direct push saturated soil testing	D, K_{OC}, and foc	Pre-design
Oil/water Separator	Production quantities	Monthly[1]
Monitoring wells (active remediation field measurements)	Water levels, pH, conductivity, turbidity, DO, ORP, and temperature	Quarterly
Monitoring wells and groundwater extraction wells	Gasoline and kerosene range hydrocarbons, TRPH, and total lead Water level and flow rate	Quarterly
Monitoring wells (post-active remediation)	Gasoline and kerosene range hydrocarbons, TRPH, and total Lead	Quarterly for one year, then semiannually

CH_4 - Methane
D - Density
$Fe^{2}+$ - Ferrous iron
foc - Fraction organic compound
K_{OC} - Partition coefficient
NO_3 - Nitrate
SO_4 - Sulfate
TDS - Total dissolved solids
TSS - Total suspended solids

Notes:
[1] – Monthly for 2 months and then quarterly

7.5 STATUS LETTERS

A summary of remedial activities and groundwater monitoring activities will be submitted quarterly, as is required in Chapter 62-770.700 (12) F.A.C. The first status report will also include system "As Built" drawings and start-up and testing results. Status reports will include requests and/or documentation for revisions to the remedial goals, system modifications, operation variances, or problems encountered with implemented solutions, per Chapter 62-770.700 (13), (14), and (15), F.A.C. Status/monitoring reports will summarize all remedial and monitoring activities and contain at least the following information:

For AFVR events:

- AFVR application date.
- Estimated volume of free product recovered.
- Hydrocarbon constituent concentrations in recovered vapors.
- Cumulative mass of hydrocarbon removed by the AFVR system.

- Free-product measurements in recovery and monitoring wells before and after AFVR event.
- Summary of system operational data.
- Summary of condition, replacement, and/or disposal of absorbent socks.
- Conclusions as to the effectiveness of the AFVR event, and recommendations for further monitoring and operation.

For groundwater remediation system:

- Start-up date,
- Total volume of groundwater extracted and disposed,
- Discharge and disposal analytical results,
- Copies of all waste manifests,
- System downtimes percentage and evaluation of efficiency for all operating components,
- All other sampling, testing, and analytical results,
- A figure showing free-product extent,
- A figure indicating the locations of all existing monitoring wells,
- A figure showing groundwater contour and contaminant maps,
- Conclusions as to the effectiveness of the remedial activities, prediction of time required for complete remediation, and recommendations on future monitoring and operations of the system.

7.5.1 Request to Discontinue Active Remediation

A request to discontinue active remediation will be prepared and submitted once site conditions warrant at any time during the remedial activities at Site 20. Submittals will be made for termination of free-product recovery, groundwater pump and treat, and natural attenuation monitoring, according to Chapter 62-770.700(15) and (16), F.A.C.

7.5.2 Post-Remedial Action Monitoring Plan

Following approval for discontinuation of active remediation, a Post-Remedial Action Monitoring Plan will be prepared and submitted. Groundwater monitoring will continue on a quarterly basis until COCs fall to predicted natural attenuation concentrations. Monitoring for natural attenuation will then proceed in selected wells on an annual basis. Status reports will be submitted, as applicable.

REFERENCES

API (American Petroleum Institute), 1986. *Safe Operating Guidelines for Vacuum Trucks in Petroleum Service, Publication 2219.*

Environment Canada, 1996. "Bunker C Fuel Oil and the Irving Whale," March.

FDEP (Florida Department of Environmental Protection), 1999. *Petroleum Contamination Site Cleanup Site Criteria, Florida Administrative Code*, Chapter 62-770. August.

NCDENR (North Carolina Department of Environment and Natural Resources), 1998. *Groundwater Section Guidelines for The Investigation and Remediation of Soil and Groundwater, Vol. II Petroleum Underground Storage Tanks, Appendix A – Remediation Technologies*, January 2.

NEESA (Naval Energy and Environmental Support Activity), 1983. *Initial Assessment Study of Naval Air Station Pensacola, Florida*, January.

NPWC (Navy Public Works Center), 1998. *Site Assessment Report , Site 20, Allegheny Pier (Pier 303), Naval Air Station, Pensacola, Florida*, July.

Perry, R.H., 1984. Perry's Chemical Engineers' Handbook. Sixth Edition. McGraw-Hill Inc.

TtNUS (Tetra Tech NUS, Inc.), 2001. *Site Assessment Report Addendum for Site 20, Allegheny Pier (Pier 303), Pensacola, Florida*, May.

USEPA (U.S. Environmental Protection Agency), 1996. *How To Evaluate Alternative Recover Free Product at Leaking Underground Storage Tank Sites, A Guide For State Regulators*, USEPA 510-R-96-001, September.

APPENDIX A

FREE-PRODUCT VOLUME CALCULATIONS

TABLE A-1

ESTIMATING THICKNESS AND VOLUME OF FREE PRODUCT

SITE 20, ALLEGHENY PIER (PIER 303)
NAS PENSACOLA, PENSACOLA, FLORIDA

Method of de Pastrovich (1979)

$$H_f = \frac{H_o(\rho_w - \rho_o)}{\rho_o}$$

Where:
H_f = thickness of mobile hydrocarbon in the adjacent formation
H_o = hydrocarbon thickness measured in well
ρ_ω = the density of water
ρ_o = the density of the liquid hydrocarbon

H_o =	18.26	cm	(0.60) ft	(TtNUS 2001)
ρ_ω =	1	gm/cm^3		
ρ_o =	0.923	gm/cm^3		
H_f =	1.52	cm	(0.05) ft	

Assumptions:
1. Density of Bunker C = 0.923 gm/cm^3 (USEPA 1996)
2. Product measured = average of 11 wells (TtNUS 2001)

This method depends only upon the density of the liquid hydrocarbon relative to the density of water. For a hydrocarbon liquid with a density of 0.8, and assuming that the density of water is equal to 1, the hydrocarbon thickness in the formation (the actual thickness) is only one-fourth the thickness measured in the well (the apparent thickness). The principal weakness of this method is that it does not account for the effects of different soil types. In general, the ratio of apparent to true free product thickness increases as soil grain size decreases. Thus, this method may be more accurate in finer grained soil (e.g., silt, clay) than coarser-grained soil (e.g., sand, loam).

Estimated Volume of Total Free Product in Subsurface

Assumptions:

Estimated area of free product	=	102,000	ft^2	(TtNUS 2001)
Actual thickness of product	=	0.05	ft	
Effective porosity	=	0.15		(TtNUS 2001)

Volume of product area = area x thickness

102,000 ft^2 x 0.05 ft = 5,098 ft^3

Note: In the absence of site specific data, effective porosity is more appropriate for use than total porosity.

Free product volume = volume of product area x effective porosity
5,098 ft^3 x 0.15 = 765 ft^3

Gallons of free product = free product volume x 7.4794 gallons/ft^3
765 ft^3 x 7.4794 gallons/ft^3 = **5,719** gallons

Total volume of free product in subsurface = 5,719 gallons

Prepared By:	Cliff Blanchard CB	Checked By:	PKJ	Approved By:	MFA
Date:	11/07/01	Date:	9/27/02	Date:	9/27/02

APPENDIX B

GROUNDWATER CALCULATIONS

TABLE B-1

ESTIMATED MASS OF DISSOLVED CONTAMINANTS IN SATURATED ZONE

SITE 20, ALLEGHENY PIER (PIER 303)
NAS PENSACOLA, PENSACOLA, FLORIDA

	Mass of Soluble Contaminants					
Well Number	Acenaphthene (ug/L)	1-Methylnaphthalene (ug/L)	2-Methylnaphthalene (ug/L)	Naphthalene (ug/L)	Lead (ug/L)	TRPH (ug/L)
SAR						
MW-3	**23**	--	--	--	4	--
MW-4	--	**540**	**580**	**330**	**31**	**54000**
MW-5	--	--	--	--	**41**	--
MW-13	--	--	--	--	**22**	--
MW-16	6	4	3	--	--	660
MW-17	4	**54**	**42**	--	--	**42000**
MW-21	**67**	11	7	--	--	330
MW-39	--	--	--	--	**144**	--
MW-42	**27**	6	--	--	--	970
MW-43	**49**	6	--	--	--	--
MW-44	**22**	--	--	--	--	--
MW-45	--	--	--	--	**62**	--
MW-49	**69**	17	--	--	--	360
MW-52	--	--	--	--	--	**14000**
MW-56	15	3	--	2	**20**	--
SARA						
MW-18	10.5	6.6	4.3	--	--	**10900**
MW-37	**44.1**	--	--	--	--	1450
MW-46	--	--	--	--	**115**	250
MW-48	**67.7**	13	3.8	--	--	--
Average Dissolved Contaminant Concentration (ug/L)	21.28	34.77	33.69	17.47	23.11	6574.74
Estimated Mass of Dissolved Contaminants (lbs)	0.70	1.15	1.11	0.58	0.76	216.66
Estimated Mass of Dissolved Contaminants (kg)	**0.32**	**0.52**	**0.50**	**0.26**	**0.35**	**98.48**

Estimated GW Volume:

ıpacted Area x Thickness x Total Porosity (n) = (153,000 ft^2)*(11.5 ft)*(0.30)*(7.48 gal/ft^3) = 3,948,318 gallons

Estimated Mass of Soluble Contaminants:

$M_{dissolved}$ (lbs) = $C_{dissolved}$ (ug/L) * V_{gw} (gal) * 3.7854 (L/gal) * 2.205E-9 (lb/ug)

where: $M_{dissolved}$ = mass of dissolved contaminants (lbs)

$C_{dissolved}$ = average dissolved contaminant concentration (ug/L)

V_{gw} = volume of impacted groundwater (gal)

Prepared By: Clifton Blanchard CFB Date: 11/07/01

Checked By: PKJ Date: 9/27/02

Approved By: MFA Date: 9/27/02

TABLE B-2

MASS OF ADSORBED CONTAMINANTS CALCULATIONS

SITE 20, ALLEGHENY PIER (PIER 303)
NAS PENSACOLA, PENSACOLA, FLORIDA

1. Concentration of Contaminants Adsorbed to Soil: C(soil) = C(dissolved) x Kd

where: C(soil) = contaminant concentration in soil (mg/kg)
C(dissolved) = average dissolved contaminant concentration (mg/L)
Kd = solid/liquid distribution coefficient (l/kg)

2. For organics: Kd = Koc x foc

where: Koc = organic carbon/water partition coefficient (l/kg) (from Mullens & Rogers, AICE 1993)
foc = fractional organic carbon content (0.5 % by weight for typical sand) (from EPA 440/5-89-002)

	Acenaphthene	Naphthalene	1-Methlynaphthalene	2-Methlynaphthalene	Lead	TPH
Koc (l/kg):	2580	2000	2660	7500	900	1580
foc (kg/kg):	0.005	0.005	0.005	0.005	0.005	0.005
Kd (l/kg) =	**12.90**	**10.00**	**13.30**	**37.50**	**4.50**	**7.90**

C(dissolved) (mg/L):	0.02	0.03	0.03	0.02	0.02	6.57
Kd (l/kg):	12.90	10.00	13.30	37.50	4.50	7.90
C(adsorbed) (mg/kg) =	**0.27**	**0.35**	**0.45**	**0.66**	**0.10**	**51.94**

3. Estimate of Contaminated Mass in Saturated Zone: 'M(soil) = Impacted Area x Impacted Thickness = (153,000 ft^2)(11.5 ft)(1.0 yd^3/27 ft^3)(1.55 tons/yd^3)(907.2 kg/ton) = **9.18E+07 kg**

4. Estimated Mass of Contaminants Adsorbed to Soil in the Saturated Zone: M(adsorbed)(lbs) = C(soil)(mg/kg) x M(soil)(kg) x 2.205E-6 (lb/mg)

C(soil) (mg/kg):	0.27450	0.347684	0.448	0.655	0.104	52
M(soil):	9.18E+07	9.18E+07	9.18E+07	9.18E+07	9.18E+07	9.18E+07
M(adsorbed) (lbs) =	**55.55**	**70.36**	**90.68**	**132.61**	**21.04**	**10,512**
M(adsorbed) (kg) =	**25.25**	**31.98**	**41.22**	**60.28**	**9.56**	**4,778**

Estimated Total Mass of Adsorbed Contaminants Based on TRPH Concentration = 10,512 lbs

TOTAL ESTIMATED MASS OF HYDROCARBONS IN SATURATED ZONE (LBS) = ADSORBED MASS + DISSOLVED MASS = $\boxed{10,728}$ lbs

Prepared by: Clifton Blanchard CFB 11/07/01
Date

Checked by: PKJ 9/27/02
Date

Approved by: MFA 9/27/02
Date

TABLE B-3

GROUNDWATER PUMP AND TREAT CAPTURE ZONE

SITE 20, ALLEGHENY PIER (PIER 303)
NAS PENSACOLA, PENSACOLA, FLORIDA

Site Information

Site:	Site 20
Location:	Pensacola, Flordia
Client:	NAVY
Project #	N0401.0000.FL0160205

	Units	Value
Well Information		
Extraction Well Numbers		EW-1 through EW-10
Static Water Level Depth	ft	6
Top of Filter Screen Depth	ft	3
Bottom of Filter Screen Depth	ft	13
Outside Diameter of Well	in	4
Open Area of Screen	in2/ft	11.3
Modeling Data		
Pumping Rate	gpm	0.5
Drawdown in Well	ft	1.3
Additional Depth of Influence	ft	4.5
Hydraulic Conductivity (K)	cm/sec	9.52E-03
Regional Hydraulic Gradient (i)	ft/ft	5.20E-04
Aquifer Transmissivity		
Screen Depth below Water Table	ft	7
Total Aquifer Thickness Contributing to	ft	11.5
Well Flow (b)	m	3.5
Hydraulic Conductivity (K)	gpd/ft2	202
Aquifer Transmissivity (T = Kb)	m2/sec	3.32E-04
	gpd/ft	2,321
Flow Velocity		
Submerged Screen Length while Pumping	ft	5.7
Flow Velocity through Screen (must be < 0.1 ft/second)	ft/sec	0.002
Capture Zone		
Distance from Well to Dividing Streamline Downgradient (A = Q/(2*3.141*T*i))	ft	95
Distance from Well to Dividing Streamline Perpendicular to Regional Groundwater Flow (B = Q/(4*T*i))	ft	149
Distance from Capture Zone Axis to Dividing Streamline Far Upgradient (C = Q/(2*T*i))	ft	298

Prepared By: Clifton Blanchard CFB 11/07/01
Date

Checked By: PKJ 9/27/02
Date

Approved By: MFA 9/27/02
Date

TABLE B-4

ESTIMATED REMEDIAL TIME
GROUNDWATER PUMP AND TREAT

SITE 20, ALLEGHENY PIER (PIER 303)
NAS PENSACOLA, PENSACOLA, FLORIDA

Plume Description

Plume Location	Shallow
Surface Area of Plume (sq ft)	153,000
Average Plume Thickness (ft)	11.5
Total Porosity	0.30
Plume Volume (gal. of water)	3,948,318

Groundwater Effective Flow Rates

Compound	Pumping Rate (Q)	Retardation Coefficient	Initial Ave.GW Concentration (C_o)	Effective Flow Rate (Q_e)	Residence Time (T_r)
	gpm		ug/L	gpd	day
Acenaphthene	5	13.90	21	518	7,622
Naphthalene	5	11.00	35	655	6,032
1-Metlynaphthalene	5	14.30	34	503	7,842
2-Metlynaphthalene	5	38.50	17	187	21,113
Lead	5	5.50	23	1309	3,016
TRPH	5	8.90	6575	809	4,881

Notes:

The retardation coefficient is calculated using the concentration distributions calculated on **Tables B-1 and B-2.**

The retardation coefficient is determined by the following equation: R = [1 + adsorbed concentration / dissolved concentration] (Remediation Engineering, Sutherson, 1997)

The concentrations shown below are based on the continuous flow mixed tank equation [C=Co*e^(-t/Tr)]. Concentrations shown below are ug/L.

$Q_e = Q/R$

T_r = Plume Volume/Q_e

gpm = gallons per minute

gpd = gallons per day

ppb = parts per billion

MG = million gallons

Contaminant Concentration Decline During Remediation

Time After Start of Remediation	Contaminant Concentration at End of Period						Total Extracted Volume	Treatment Completed
t (months)	Acenaphthene	Naphthalene	1-Metlynaphthalene	2-Metlynaphthalene	Lead	TRPH	MG	
0	21	35	34	17	23	6575	0.22	
1	21	35	34	17	23	6534	0.44	
2	21	34	33	17	23	6493	0.66	
3	21	34	33	17	22	6453	0.88	
4	21	34	33	17	22	6413	1.10	
5	21	34	33	17	22	6373	1.31	
6	21	34	33	17	22	6333	1.53	
7	21	34	33	17	22	6294	1.75	
8	21	33	33	17	21	6255	1.97	
9	21	33	33	17	21	6216	2.19	
10	20	33	32	17	21	6177	2.41	
11	20	33	32	17	21	6139	2.63	
12	20	33	32	17	20	6101	2.85	
13	20	33	32	17	20	6063	3.07	
14	20	32	32	17	20	6025	3.29	
15	20	32	32	17	20	5988	3.50	
16	20	32	32	17	20	5951	3.72	
17	20	32	32	17	19	5914	3.94	
18	20	32	31	17	19	5877	4.16	
19	20	32	31	17	19	5841	4.38	
20	20	31	31	17	19	5804	4.60	
21	20	31	31	17	19	5768	4.82	
22	19	31	31	17	19	5732	5.04	
23	19	31	31	17	18	5697	5.26	
24	19	31	31	17	18	5661	5.48	
25	19	31	31	17	18	5626	5.69	
26	19	30	30	17	18	5591	5.91	
27	19	30	30	17	18	5556	6.13	
28	19	30	30	17	17	5522	6.35	
29	19	30	30	17	17	5488	6.57	
30	19	30	30	17	17	5454	6.79	
31	19	30	30	17	17	5420	7.01	
32	19	30	30	17	17	5386	7.23	
33	19	29	30	17	17	5353	7.45	
34	19	29	30	17	16	5319	7.67	
35	19	29	29	17	16	5286	7.88	
36	18	29	29	17	16	5253	8.10	
37	19	29	29	17	16	5221	8.32	
38	18	29	29	17	16	5188	8.54	
39	18	29	29	17	16	5156	8.76	
40	18	28	29	16	15	5124	8.98	
41	18	28	29	16	15	5092	9.20	
42	18	28	29	16	15	5061	9.42	
43	18	28	29	16	15	5029	9.64	
44	18	28	28	16	15	4998	9.86	
45	18	28	28	16	15	4967	10.07	

TABLE B-4

ESTIMATED REMEDIAL TIME
GROUNDWATER PUMP AND TREAT

SITE 20, ALLEGHENY PIER (PIER 303)
NAS PENSACOLA, PENSACOLA, FLORIDA

Time After Start of Remediation	Contaminant Concentration at End of Period						Total Extracted Volume	Treatment Completed
t (months)	Acenaphthene	Naphthalene	1-Metlynaphthalene	2-Metlynaphthalene	Lead	TRPH	MG[1]	
46	18	28	28	16	15	4936	10.29	
47	18	27	28	16	14	4905	10.51	
48	18	27	28	16	14	4875	10.73	
49	17	27	28	16	14	4845	10.95	
50	17	27	28	16	14	4814	11.17	
51	17	27	28	16	14	4785	11.39	
52	17	27	28	16	14	4755	11.61	
53	17	27	27	16	14	4725	11.83	
54	17	26	27	16	13	4696	12.05	
55	17	26	27	16	13	4667	12.26	
56	17	26	27	16	13	4638	12.48	
57	17	26	27	16	13	4609	12.70	
58	17	26	27	16	13	4580	12.92	
59	17	26	27	16	13	4552	13.14	
60	17	26	27	16	13	4524	13.36	
61	17	26	27	16	12	4495	13.58	
62	17	25	26	16	12	4468	13.80	
63	17	25	26	16	12	4440	14.02	
64	16	25	26	16	12	4412	14.24	
65	16	25	26	16	12	4385	14.45	
66	16	25	26	16	12	4358	14.67	
67	16	25	26	16	12	4330	14.89	
68	16	25	26	16	12	4304	15.11	
69	16	25	26	16	12	4277	15.33	
70	16	24	26	16	11	4250	15.55	
71	16	24	26	16	11	4224	15.77	
72	16	24	25	16	11	4198	15.99	
73	16	24	25	16	11	4172	16.21	
74	16	24	25	16	11	4146	16.43	
75	16	24	25	16	11	4120	16.64	
76	16	24	25	16	11	4094	16.86	
77	16	24	25	16	11	4069	17.08	
78	16	23	25	16	11	4044	17.30	
79	16	23	25	16	10	4018	17.52	
80	15	23	25	16	10	3993	17.74	
81	15	23	25	16	10	3969	17.96	
82	15	23	25	16	10	3944	18.18	
83	15	23	24	16	10	3919	18.40	
84	15	23	24	15	10	3895	18.62	
85	15	23	24	15	10	3871	18.83	
86	15	23	24	15	10	3847	19.05	
87	15	22	24	15	10	3823	19.27	
88	15	22	24	15	10	3799	19.49	
89	15	22	24	15	9	3776	19.71	
90	15	22	24	15	9	3752	19.93	
91	15	22	24	15	9	3729	20.15	
92	15	22	24	15	9	3706	20.37	
93	15	22	23	15	9	3683	20.59	
94	15	22	23	15	9	3660	20.81	
95	15	22	23	15	9	3637	21.02	
96	15	21	23	15	9	3614	21.24	
97	14	21	23	15	9	3592	21.46	
98	14	21	23	15	9	3570	21.68	
99	14	21	23	15	9	3547	21.90	
100	14	21	23	15	8	3525	22.12	
101	14	21	23	15	8	3504	22.34	
102	14	21	23	15	8	3482	22.56	
103	14	21	23	15	8	3460	22.78	
104	14	21	23	15	8	3439	23.00	
105	14	20	22	15	8	3417	23.21	
106	14	20	22	15	8	3396	23.43	
107	14	20	22	15	8	3375	23.65	
108	14	20	22	15	8	3354	23.87	
109	14	20	22	15	8	3333	24.09	
110	14	20	22	15	8	3312	24.31	
111	14	20	22	15	8	3292	24.53	
112	14	20	22	15	7	3271	24.75	
113	14	20	22	15	7	3251	24.97	
114	14	20	22	15	7	3231	25.19	
115	13	19	22	15	7	3211	25.40	
116	13	19	21	15	7	3191	25.62	
117	13	19	21	15	7	3171	25.84	
118	13	19	21	15	7	3151	26.06	
119	13	19	21	15	7	3132	26.28	
120	13	19	21	15	7	3112	26.50	
121	13	19	21	15	7	3093	26.72	
122	13	19	21	15	7	3074	26.94	
123	13	19	21	15	7	3055	27.16	
124	13	19	21	15	7	3036	27.38	

TABLE B-4

ESTIMATED REMEDIAL TIME
GROUNDWATER PUMP AND TREAT

SITE 20, ALLEGHENY PIER (PIER 303)
NAS PENSACOLA, PENSACOLA, FLORIDA

Time After Start of Remediation	Contaminant Concentration at End of Period						Total Extracted Volume	Treatment Completed
125	13	19	21	15	7	3017	27.59	
126	13	18	21	15	6	2998	27.81	
127	13	18	21	15	6	2979	28.03	
128	13	18	21	15	6	2961	28.25	
129	13	18	20	15	6	2943	28.47	
130	13	18	20	14	6	2924	28.69	
131	13	18	20	14	6	2906	28.91	
132	13	18	20	14	6	2888	29.13	
133	13	18	20	14	6	2870	29.35	
134	12	18	20	14	6	2852	29.57	
135	12	18	20	14	6	2835	29.78	
136	12	18	20	14	6	2817	30.00	
137	12	17	20	14	6	2799	30.22	
138	12	17	20	14	6	2782	30.44	
139	12	17	20	14	6	2765	30.66	
140	12	17	20	14	6	2748	30.88	
141	12	17	19	14	6	2731	31.10	
142	12	17	19	14	6	2714	31.32	
143	12	17	19	14	5	2697	31.54	
144	12	17	19	14	5	2680	31.76	
145	12	17	19	14	5	2663	31.97	
146	12	17	19	14	5	2647	32.19	
147	12	17	19	14	5	2630	32.41	
148	12	16	19	14	5	2614	32.63	
149	12	16	19	14	5	2598	32.85	
150	12	16	19	14	5	2582	33.07	
151	12	16	19	14	5	2566	33.29	
152	12	16	19	14	5	2550	33.51	
153	12	16	19	14	5	2534	33.73	
154	12	16	19	14	5	2518	33.95	
155	11	16	18	14	5	2502	34.16	
156	11	16	18	14	5	2487	34.38	
157	11	16	18	14	5	2471	34.60	
158	11	16	18	14	5	2456	34.82	
159	11	16	18	14	5	2441	35.04	
160	11	16	18	14	5	2426	35.26	
161	11	15	18	14	5	2411	35.48	
162	11	15	18	14	5	2396	35.70	
163	11	15	18	14	4	2381	35.92	
164	11	15	18	14	4	2366	36.14	
165	11	15	18	14	4	2351	36.35	
166	11	15	18	14	4	2337	36.57	

Prepared By: Clifton Blanchard CFB 11/12/2001
Date

Checked By: PKJ 9/27/02
Date

Approved By: MFA 9/27/02
Date

APPENDIX B-5
AQUIFER CALCULATIONS

Based On: Darcy Flow Equation

References:

1. *Groundwater,* by Freeze and Cherry, pages 17, 71, and 72
2. Site Assessment Report Addendum, TtNUS, 2000.

B.5.1 - CALCULATION OF HORIZONTAL HYDRAULIC GRADIENT

EQUATION: $i = \Delta H/\Delta L = {}^{dh}/_{dl}$

WHERE:

i = hydraulic gradient
dh = difference in hydraulic head
dl = linear distance over which the change in head is observed

CALCULATIONS - JULY 2000 DATA (TtNUS, 2000)

$i_{MW-9/MW-14}$ = (19.31 ft -19.13 ft) / 340 ft = 0.18 ft / 340 ft = **0.00053 ft/ft**

$i_{MW-34/MW-37}$ = (19.35 ft -19.10 ft) / 379 ft = 0.25 ft / 379 ft = **0.00066 ft/ft**

$i_{MW-9/MW-23}$ = (19.31 ft -19.16 ft) / 399 ft = 0.15 ft / 399 ft = **0.00038 ft/ft**

CALCULATION OF THE AVERAGE (ARITHMETIC MEAN) GRADIENT:

i_{AVE} = (0.00053 ft/ft + 0.00066 ft/ft + 0.00038 ft/ft) / 3 = **0.00052 ft/ft**

B.5.2 - CALCULATION OF GROUNDWATER SEEPAGE VELOCITY

EQUATION: $V = K_{av}\, i/\eta_e$

WHERE

K_{av} = 3.12 x 10^{-4} ft/sec
i = 0.00052
η_e = 0.15 – for sand (from Fetter, page 69)

Groundwater Seepage (Average Linear) Velocity

$$V = \frac{(3.12 \times 10^{-4}\ \text{ft/sec})(0.00052)}{0.15} = \mathbf{1.08 \times 10^{-6}\ ft/sec}$$

Converting to feet per year (ft/yr):

1.08 X 10^{-6} ft/sec X 31,536,000 sec/yr = **34.1 ft/yr**

PREPARED BY Cliff Blanchard CFB 11/07/01
DATE

CHECKED BY: PKJ 9/27/02
DATE

APPROVED BY: MFA 9/27/02
DATE

APPENDIX C

REMEDIAL ALTERNATIVE COST ESTIMATES

TABLE C-1

FREE-PRODUCT RECOVERY ALTERNATIVE NO. 1

SITE 20, ALLEGHENY PIER (PIER 303)
NAS PENSACOLA, PENSACOLA, FLORIDA

Free-Product Recovery Alternative No. 1-LUCs, Passive Skimming, and Monitoring

DIRECT COSTS	Quantity	Unit	Unit Cost	Total Cost
Project Planning				
Prepare Work Plan	40	hr	$33.79	$1,352
Project Scheduling and Procurement	8	hr	$33.79	$270
Mobilization (for new monitoring wells)				
Equipment Mob/Demob	1	ea	$450.00	$450
Mobilize/Demobilize Personnel (2 persons)	1	ea	$675.00	$675
Decontamination				
Temporary Decon Pad	1	ea	$1,000.00	$1,000
Decon Water Disposal	10	ea	$125.00	$1,250
Decon Water Storage Drums	10	ea	$45.00	$450
PPE (2 persons for 15 days)	30	day	$30.00	$900
Decon Equipment (pressure washer)	10	day	$50.00	$500
New Monitoring Wells (10)				
Hollow Stem Auger (10 wells to 15 ft)	150	ft	$25.00	$3,750
4-inch PVC well casing	50	ft	$10.00	$500
Construction (2-man crew)	15	day	$450.00	$6,750
4-inch well screen	100	ft	$8.00	$800
Professional Services				
Drawings Preparation and Eng. Oversight	40	hr	$33.79	$1,352
Land Use Controls				
Construction (2-man crew)	1	day	$450.00	$450
Prepare Land Use Plan	80	hr	$33.79	$2,703
Modify Master Plan and Prepare Deed Restrictions	50	hr	$33.79	$1,690
Free Product Removal/Skimming System Installation				
assume qtrly change out required				
2-inch absorbent socks (for 11 wells)	44	ea	$368	$16,191
4-inch absorbent socks (for 10 wells)	40	ea	450	$18,000
1 Technician, 1 day @ 8 hrs	8	hrs	$35	$280
1 Jr. Level Engineer, 1 day @ 8 hrs	8	hrs	$45	$360
Total Direct Costs				**$59,672**

TABLE C-1

FREE-PRODUCT RECOVERY ALTERNATIVE NO. 1

SITE 20, ALLEGHENY PIER (PIER 303)
NAS PENSACOLA, PENSACOLA, FLORIDA

DIRECT COSTS	Quantity	Unit	Unit Cost	Total Cost
TREATMENT SYSTEM O&M (annual)				
System Maintenance				
Labor:				
Technician, 24 hrs per month	288	hr	$30	$8,640
Sr. Engineer, 2 hours per month	24	hr	$90	$2,160
Project Mgr, 2 hrs per month	24	hr	$100	$2,400
Recovered Product Drum Disposal, 6 per year	6	ea	$150	$900
Absorbent Socks Drum Disposal, 4 per year	4	ea	$150	$600
Total				**$14,700**
EXPENDABLES AND EQUIPMENT RENTAL:				
Gloves (1 box)	1	box	$10	$10
First Aid kit	1	ls	$50	$50
Water/hydrocarbon interface probe	30	days	$25	$750
Total Expendables and Equipment Rental:				$810
Total cost for treatment system O&M				**$15,510**
Quarterly Status Reports				
(assume four status reports)				
1 Jr. Level Geologist 16 hrs	64		$45	$2,880
1 Senior Geologist 4 hrs	16		$80	$1,280
Technical Expert 2 hrs	8		$75	$600
Production:				$0
Word Processing 8 hrs	32		$35	$1,120
Editor 2 hrs	8		$60	$480
Total				**$6,360**
Total				**$81,542**

TABLE C-2

FREE-PRODUCT RECOVERY ALTERNATIVE NO. 2

SITE 20, ALLEGHENY PIER (PIER 303)
NAS PENSACOLA, PENSACOLA, FLORIDA

Free-Product Recovery Alternative No. 2-LUCs, Water Table Depression, and Monitoring

DIRECT COSTS	Quantity	Unit	Unit Cost	Total Cost
Project Planning				
Prepare Work Plan	40	hr	$33.79	$1,352
Project Scheduling and Procurement	8	hr	$33.79	$270
Mobilization (for new monitoring wells)				
Equipment Mob/Demob	1	ea	$450.00	$450
Mobilize/Demobilize Personnel (2 persons)	1	ea	$675.00	$675
Decontamination				
Temporary Decon Pad	1	ea	$1,000.00	$1,000
Decon Water Disposal	10	ea	$125.00	$1,250
Decon Water Storage Drums	10	ea	$45.00	$450
PPE (2 persons for 15 days)	30	day	$30.00	$900
Decon Equipment (pressure washer)	10	day	$50.00	$500
New Monitoring Wells (10)				
Hollow Stem Auger (10 wells to 15 ft)	150	ft	$25.00	$3,750
4-inch PVC well casing	50	ft	$10.00	$500
Construction (2-man crew)	15	day	$450.00	$6,750
4-inch well screen	100	ft	$8.00	$800
Professional Services				
Drawings Preparation and Eng. Oversight	40	hr	$33.79	$1,352
Land Use Controls				
Construction (2-man crew)	1	day	$450.00	$450
Prepare Land Use Plan	80	hr	$33.79	$2,703
Modify Master Plan and Prepare Deed Restrictions	50	hr	$33.79	$1,690
Free Product Recovery with Water Table Depression				
Pneumatic Product Recovery Pump	4	ea	$602	$2,408
80 Gallon Air Compressor	1	ea	$4,942	$4,942
20 gpm Oil/Water Separator	1	ea	$9,199	$9,199
Air Supply and Exhaust Hose	400	ft	$2	$800
Hydrocarbon Discharge Line	400	ft	$2	$800
Electrical site usage	12	mo	$240	$2,880
15 gpm, 1/2 HP, Transfer Pump with motor valves and piping	4	ea	$1,128	$4,512
4,000 Polyethylene Aboveground Holding Tank	12	mo	$540	$6,480
Totalizing flow meter	4	ea	$300	$1,200
Flow indicator	4	ea	$100	$400
Pressure guage	4	ea	$100	$400
Sewer connection fee	1	ea	$2,150	$2,150
Labor				
1 Technician, 1 week @ 50 hrs/wk	50	hrs	$35	$1,750
1 Jr. Level Engineer, 1 week @ 50 hrs/wk	50	hrs	$45	$2,250
1 Sr. Engineer, 16 hours	16	hrs	$90	$1,440
TOTAL Direct Costs				**$66,452**

TABLE C-2

FREE-PRODUCT RECOVERY ALTERNATIVE NO. 2

SITE 20, ALLEGHENY PIER (PIER 303)
NAS PENSACOLA, PENSACOLA, FLORIDA

DIRECT COSTS	Quantity	Unit	Unit Cost	Total Cost
TREATMENT SYSTEM O&M (annual)				
System Maintenance				
Labor:				
Jr. Engineer, 25 hrs per month, system operating data, control	300	hr	$45	$13,500
Sr. Engineer, 5 hours per month	60	hr	$90	$5,400
Technician, 25 hrs per month	300	hr	$30	$9,000
Project Mgr, 2 hrs per month	24	hr	$100	$2,400
Electrician, 15 hours per year	15	hr	$60	$900
TOTAL				$31,200
Quarterly Status Reports				
(assume four status reports with groundwater analytical results reported in last quarter)				
1 Jr. Level Geologist 30 hrs	64		$45	$2,880
1 Senior Geologist 10 hrs	16		$80	$1,280
Technical Expert 5 hrs	8		$75	$600
Production:				$0
Word Processing 8 hrs	32		$35	$1,120
Editor 2 hrs	8		$60	$480
Total				$6,360
Total				**$104,012**

TABLE C-3

FREE-PRODUCT RECOVERY ALTERNATIVE NO. 3

SITE 20, ALLEGHENY PIER (PIER 303)
NAS PENSACOLA, PENSACOLA, FLORIDA

Free-Product Recovery Alternative No. 3-LUCs, AFVR, Passive Skimming, and Monitoring

DIRECT COSTS	Quantity	Unit	Unit Cost	Total Cost
Project Planning				
Prepare Work Plan	40	hr	$33.79	$1,352
Project Scheduling and Procurement	8	hr	$33.79	$270
Land Use Controls				
Construction (2-man crew)	1	day	$450.00	$450
Prepare Land Use Plan	80	hr	$33.79	$2,703
Modify Master Plan and Prepare Deed Restrictions	50	hr	$33.79	$1,690
Free Product Recovery Via Mobile Enhanced Multi-Phase Extraction				
8 hour AFVR event (2 trucks)	6	ea	$6,200	$37,200.00
Oily Water Removal, 6 events @ 2000 gal/event	12000	gal	$0.25	$3,000
Free Product Removal/Skimming System Installation				
assume qtrly change out required				
2-inch absorbent socks (for 11 wells)	44	ea	$368	16,191
1 Technician, 1 day @ 8 hrs	8	hrs	$35	280
1 Jr. Level Engineer, 1 day @ 8 hrs	8	hrs	$45	360
Total Direct Costs				**63,496**
TREATMENT SYSTEM O&M (annual)				
System Maintenance				
Labor:				
Technician, 12 hrs per month	144	hr	$30	4,320
Sr. Engineer, 2 hours per month	24	hr	$90	2,160
Project Mgr, 2 hrs per month	24	hr	$100	2,400
Absorbent socks drum disposal, 4 per year	4	ea	$150	600
Total				**9,480**
AFVR Costs for Oversight and free product monitoring				
Oversight by Staff Engineer during AFVR event (10 hrs per event)	60	hr	$45	$2,700
Free Product Monitoring by Technician	144	hr	$30	$4,320
(Assume 8 hrs once every two weeks for 9 month project duration)				
Rental of water/hydrocarbon interface probe	30	day	$25	$750
Total				**$7,770**
Status letter Reports				
(assume six reports, one after each event)				
1 Jr. Level Geologist	60	hr	$45	$2,700
1 Senior Geologist	24	hr	$80	$1,920
Technical Expert	18	hr	$75	$1,350
Production:				
Word Processing				$0
Editor	30	hr	$35	$1,050
	12	hr	$60	$720
Total				**$7,740**

TABLE C-3

FREE-PRODUCT RECOVERY ALTERNATIVE NO. 3

SITE 20, ALLEGHENY PIER (PIER 303)
NAS PENSACOLA, PENSACOLA, FLORIDA

DIRECT COSTS	Quantity	Unit	Unit Cost	Total Cost
REPORTING, Site Activities Report/System Operation Report:				
1 Jr. Level Geologist	100	hr	$45	$4,500
1 Senior Geologist	16	hr	$80	$1,280
Technical Expert	6	hr	$75	$450
Word Processing	15	hr	$35	$525
Editor	8	hr	$60	$480
CADD Operator	15	hr	$40	$600
Reproduction: 100 pgs @ 20 copies	2000	pg	$0.10	$200
Shipping/binding: 20 reports	20	ea	$20	$400
Total Report/Modeling Cost:				**$8,435**
TOTAL PROJECT COST				**$96,921**

TABLE C-4

GROUNDWATER REMEDIATION ALTERNATIVE NO. 1
GROUNDWATER PUMP AND TREAT/DISCHARGE TO POTW DETAILED COST

SITE 20, ALLEGHENY PIER (PIER 303)
NAS PENSACOLA, PENSACOLA, FLORIDA

	Quantity	Unit	Unit Cost	Total Cost
A. PRE-DESIGN DATA				
(1) Groundwater and product sampling and analysis				
(a) Groundwater and Product Sampling and Analysis Work Plan				
1 Jr. Level Engineer	40	hrs	$45	$1,800
1 Senior Engineer	8	hrs	$90	$720
Word processing	4	hrs	$35	$140
Technical Expert	6	hrs	$75	$450
Editor	2	hrs	$60	$120
CADD operator, 2 dwgs per report @ 8 hours per dwg	16	hrs	$60	$960
Reproduction & Shipping/binding	1	ls	$400	$400
(b) Groundwater Analysis for Contaminant Monitoring (assume 30 wells, 3 QC)				
Polycyclic Aromatic Hydrocarbons, SW-846 8310	33	ea	$150	$4,950
Total Lead, SW-846 Method 7421	33	ea	$15	$495
TRPH (FLPRO)	33	ea	$90	$2,970
(c) Groundwater Analysis for Natural Attenuation Parameters (assume 10 wells - no QA)				
Methane	10	ea	$85	$850
Ferrous Iron (Fe^{2+})	10	ea	$15	$150
Sulfate (SO_4)	10	ea	$15	$150
Nitrate (NO_3)	10	ea	$15	$150
(d) Expendables and Equipment Rental				
Gloves (2 box per event)	2	box	$10	$20
Teflon tubing (600 feet per event)	600	ft	$2.00	$1,200
Silicon tubing (200 feet per event)	200	ft	$2.00	$400
Shipping and supplies (tape, bubble wrap, ice)	1	ls	$400	$400
Rental of Horiba U-22 meter for conductivity, Oxidation-Reduction Potential, pH, dissolved oxygen, turbidity, and temperature.	10	days	$60	$600
Pumps for purging wells (assume 2 for 10 days)	20	days	$35	$700
First Aid kit	1	ls	$50	$50
Water/Hydrocarbon Interface Probe	10	days	$25	$250
Disposal of purge water, assume nonhaz., drums	8	ls	$150	$1,200
Car Rental w/fuel	10	ls	$65	$650
(e) Labor				
1 Technician, 10 days per sampling event @ 10 hour days	100	hrs	$30	$3,000
1 Geologist, 10 days per sampling event @ 10 hour days	100	hrs	$45	$4,500
Subtotal Pre-Design Data Collection Cost:				**$22,685**
B. GROUNDWATER TREATEMENT SYSTEM ENGINEERING DESIGN				
Engineering includes preparation of all submittals, such as HASP, Erosion and Sediment Control Plan, Waste Management Plan, Construction Documentation Report, System Operations Manual, "As Builts" and Start and Testing Report (20% of construction cost)	1	ls	$47,000	$47,000
Subtotal System Engineering Design Cost:				**$47,000**

TABLE C-4

GROUNDWATER REMEDIATION ALTERNATIVE NO. 1
GROUNDWATER PUMP AND TREAT/DISCHARGE TO POTW DETAILED COST

SITE 20, ALLEGHENY PIER (PIER 303)
NAS PENSACOLA, PENSACOLA, FLORIDA

	Quantity	Unit	Unit Cost	Total Cost
C. SITE PREPARATION				
(1) Mobilization	1	ls	$5,000	$5,000
(2) Construction office trailer	3	mo	$600	$1,800
(3) Trailer delivery, setup, removal	2	ea	$1,000	$2,000
(4) Storage bin	3	mo	$120	$360
(5) Construction office and storage area fencing, 20'x30'	100	ft	$18	$1,800
(6) Signs, temp fencing, barricades to seclude construction area	1	ls	$1,500	$1,500
(7) Pressure washer and water tank	1	mo	$504	$504
(8) Plastic sheeting, drums, pumps, hoses, supplies	1	ls	$2,000	$2,000
(9) Oversight Labor				
1 Jr. Level Engineer, 5 days @ 8 hrs/Day	40	hrs	$45	$1,800
1 Sr. Engineer, 16 hours	16	hrs	$90	$1,440
Subtotal Site Preparation				$18,204
D. GROUNDWATER TREATMENT SYSTEM CONSTRUCTION				
(1) Well Installation				
(a) Extraction wells, 10 wells @ 4'ID, PVC, 20' average bls	200	ft	$100	$20,000
(b) Electrical to pumps	1	ls	$3,000	$3,000
(c) Groundwater extraction pump, 2" submersible pump, 0.25-3 GPM, installed	10	ea	$1,200	$12,000
(d) Testing for Lead K_d (K_{oc} & foc)	1	ls	$3,500	$3,500
(e) Oversight and Sampling Labor				
1 Jr. Level Engineer, 4 weeks @ 40 hrs/wk	160	hrs	$45	$7,200
1 Sr. Engineer	32	hrs	$90	$2,880
Subtotal Well Installation Cost				$48,580
(2) Collection System				
(a) Piping for groundwater extraction wells to treatment sytem, 2" ID PVC (double walled), w/handholes, includes excavation and backfilling	1800	ft	$18	$32,400
(b) Electrician w/helper, 1 week @ 50 hrs/wk	50	hrs	$90	$4,500
(c) Oversight Labor				
1 Jr. Level Engineer, 1 week @ 50 hrs/wk	50	hrs	$45	$2,250
1 Sr. Engineer, 24 hours	24	hrs	$90	$2,160
Subtotal Piping and Equipment				$41,310

GROUNDWATER REMEDIATION ALTERNATIVE NO. 1
GROUNDWATER PUMP AND TREAT/DISCHARGE TO POTW DETAILED COST

SITE 20, ALLEGHENY PIER (PIER 303)
NAS PENSACOLA, PENSACOLA, FLORIDA

	Quantity	Unit	Unit Cost	Total Cost
(3) Treatment System				
(a) Electrical connection for treatment system (including electric poles, cable, transformer, phone line for telemetry)	1	ls	$2,500	$2,500
(b) Waterline Connection for Treatment System (includes underground piping and appurtenences)	1	ls	$1,000	$1,000
(c) Fencing, 20'x30', with manway and 14' gate	100	ft	$18	$1,800
(d) Gravity oil/water separator, 1000-gallon fiberglass	1	ls	$3,800	$3,800
(e) Discharge pump (Duplex system)	1	ls	$2,000	$2,000
(f) Force main to POTW collection pipeline	200	ft	$10	$2,000
(g) Associated piping and valves @ 12% total treatment system cost	1	ls	$14,551	$14,551
(h) Flow meters	2	ls	$300	$600
(i) Flow indicators	2	ls	$150	$300
(j) Instrument panel, controls	1	ls	$3,000	$3,000
(k) Transfer pump	1	ls	$1,000	$1,000
(l) Telemetry	1	ls	$10,000	$10,000
(m) Oversite Labor				
1 Jr. Engineer (8 weeks @ 50 hrs/week)	400	hrs	$45	$18,000
1 Sr. Engineer (8 weeks @ 16 hrs/week)	124	hrs	$90	$11,160
Subtotal Treatment System Cost				$71,711
Subtotal Capital Cost				$249,490
E. GROUNDWATER TREATMENT SYSTEM O&M (annual)				
(1) Labor				
(a) Jr. Engineer, 12 hrs per month, system operating data, control	144	hr	$45	$6,480
(b) Sr. Engineer, 4 hours per month	48	hr	$90	$4,320
(c) Technician, 20 hrs per month	240	hr	$30	$7,200
(d) Project Mgr, 2 hrs per month	12	hr	$100	$1,200
(e) Electrician, 4 hours per year	4	hr	$75	$300
(2) POTW discharge fee	2,628	Kgal	$6	$15,768
(3) Misc. equip/supplies	12	mo	$800	$9,600
(4) Electricity (40 kW*24 hr/day*365 day/yr = 350,400 kWh/yr)	350,400	kWh	$0.08	$28,032
(5) Water (assume $500/year)	1	ls	$500	$500
Subtotal Groundwater System O&M				$73,400

GROUNDWATER REMEDIATION ALTERNATIVE NO. 1
GROUNDWATER PUMP AND TREAT/DISCHARGE TO POTW DETAILED COST

SITE 20, ALLEGHENY PIER (PIER 303)
NAS PENSACOLA, PENSACOLA, FLORIDA

	Quantity	Unit	Unit Cost	Total Cost
H. REMEDIAL ACTION MONITORING				
(1) Quarterly Groundwater Monitoring (Includes 4 monitoring wells, 3 GW extraction wells, and 1 QA)				
(a) Labor				
1 Technician, 5 days per sampling event @ 10 hour days	50	hrs	$30	$1,500
1 Geologist, 5 days per sampling event @ 10 hour days	50	hrs	$45	$2,250
Car Renta w/fuel (5 days per event)	5	ls	$65	$325
(b) Analysis				
Polycyclic Aromatic Hydrocarbons, SW-846 8310	8	ea	$150	$1,200
Total Lead, SW-846 Method 7421	8	ea	$15	$120
TRPH (FLPRO)	8	ea	$90	$720
(c) Expendables and Equipment Rental				
Gloves (2 boxes per event)	4	box	$10	$40
Teflon tubing (400 feet per event)	400	ft	$2.00	$800
Silicon tubing (50 feet per event)	50	ft	$2.00	$100
Shipping and supplies (tape, bubble wrap, ice)	1	ls	$250	$250
Rental of Horiba U-22 meter for conductivity, Oxidation-Reduction Potential, pH, dissolved oxygen, turbidity, and temperature.	4	days	$60	$240
Pumps for purging wells (2 pumps, 3 days rental per event)	6	days	$35	$210
First Aid kit	1	ls	$50	$50
Water/Hydrocarbon Interface Probe	5	days	$25	$125
Disposal of purge water, assume nonhaz., drums	8	ea	$150	$1,200
Subtotal Quarterly Groundwater Monitoring Costs				**$9,130**
(2) Treatment System Monitoring (qtrly)				
(a) Labor:				
performed in conjunction with other site activiites				
(b) Effluent Analysis (1 QA)				
Polycyclic Aromatic Hydrocarbons, SW-846 8310	2	ea	$150	$300
Total Lead, SW-846 Method 7421	2	ea	$15	$30
TRPH (FLPRO)	2	ea	$80	$160
Total Suspended Solids	2	ea	$15	$30
Total Dissolved Solids	2	ea	$15	$30
Total Iron	2	ea	$15	$30
Subtotal Treatment System Monitoring Costs				**$580**

GROUNDWATER REMEDIATION ALTERNATIVE NO. 1
GROUNDWATER PUMP AND TREAT/DISCHARGE TO POTW DETAILED COST

SITE 20, ALLEGHENY PIER (PIER 303)
NAS PENSACOLA, PENSACOLA, FLORIDA

	Quantity	Unit	Unit Cost	Total Cost
(3) Post-Active Remdial Action Monitoring (4 wells, 1 QA, for Natural Attenuation annually)				
(a) Labor:				
1 Technician, 3 days per sampling event @ 10 hour days	30	hrs	$30	$900
1 Geologist, 3 days per sampling event @ 10 hour days	30	hrs	$45	$1,350
Car Renta w/fuel	3	days	$65	$195
(b) Analysis				
Polycyclic Aromatic Hydrocarbons, SW-846 8310	5	ea	$150	$750
Total Lead, SW-846 Method 7421	5	ea	$15	$75
TRPH (FLPRO)	5	ea	$90	$450
(c) Expendables and Equipment Rental				
Gloves	2	box	$10	$20
Teflon tubing	200	ft	$2.00	$400
Silicon tubing	50	ft	$2.00	$100
Shipping and supplies (tape, bubble wrap, ice)	1	ls	$250	$250
Rental of Horiba U-22 meter for conductivity, Oxidation-Reduction Potential, pH, dissolved oxygen, turbidity, and temperature.	3	days	$60	$180
Pumps for purging wells (2 pumps, 2 days rental)	4	days	$35	$140
First Aid kit	1	ls	$50	$50
Water level indicator	3	days	$25	$75
Disposal of purge water, assume nonhaz., drums	2	ls	$150	$300
Subtotal Quarterly Groundwater Monitoring Costs				$5,235
I. SUBMITTALS				
(1) Status/Monitoring Report				
(a) 1 Jr. Level Engineer	80	hrs	$45	$3,600
(b) 1 Senior Engineer	16	hrs	$90	$1,440
(c) Word processing	6	hrs	$35	$210
(d) Technical Expert	6	hrs	$75	$450
(e) Editor	6	hrs	$60	$360
(f) CADD operator, 4 dwgs per report @ 2 hours per dwg	8	hrs	$40	$320
(g) Reproduction & Shipping/binding: 20 reports, 100 pgs @ 20 copies	1	ls	$600	$600
Subtotal Status/Monitoring Report Cost:				$6,980
(2) Request for Discontinuation of Active Remediation				
(a) 1 Jr. Level Engineer	32	hrs	$45	$1,440
(b) 1 Senior Engineer	4	hrs	$90	$360
(c) Word processing	4	hrs	$35	$140
(d) Technical Expert	12	hrs	$75	$900
(e) Editor	4	hrs	$60	$240
(f) CADD operator, 2 dwgs per report @ 2 hours per dwg	4	hrs	$40	$160
(g) Reproduction & Shipping/binding: 20 reports, 100 pgs @ 20 copies	1	ls	$600	$600
Subtotal Request for Discontinuation of Active Remediation Report Cost:				$3,840

TABLE C-4

GROUNDWATER REMEDIATION ALTERNATIVE NO. 1
GROUNDWATER PUMP AND TREAT/DISCHARGE TO POTW DETAILED COST

SITE 20, ALLEGHENY PIER (PIER 303)
NAS PENSACOLA, PENSACOLA, FLORIDA

	Quantity	Unit	Unit Cost	Total Cost
(3) Post-Remedial Monitoring Plan				
(a) 1 Jr. Level Engineer	40	hrs	$45	$1,800
(b) 1 Senior Engineer	4	hrs	$90	$360
(c) Word processing	4	hrs	$35	$140
(d) Technical Expert	4	hrs	$75	$300
(e) Editor	4	hrs	$60	$240
(f) CADD operator, 2 dwgs per report @ 2 hours per dwg	4	hrs	$40	$160
(g) Reproduction & Shipping/binding: 20 reports, 80 pgs @ 20 copies	1	ls	$520	$520
Subtotal Post-Remedial Monitoring Plan Cost:				$3,520
(4) Post-Remedial Monitoring Report				
(a) 1 Jr. Level Engineer	32	hrs	$45	$1,440
(b) 1 Senior Engineer	2	hrs	$90	$180
(c) Word processing	2	hrs	$35	$70
(d) Technical Expert	2	hrs	$75	$150
(e) Editor	2	hrs	$60	$120
(f) CADD operator, 2 dwgs per report @ 2 hours per dwg	4	hrs	$40	$160
(g) Reproduction & Shipping/binding: 20 reports, 60 pgs @ 20 copies	1	ls	$450	$450
Subtotal Post-Remedial Monitoring Plan Cost:				$2,570
				$354,745

TABLE C-4.1

GROUNDWATER REMEDIATION ALTERNATIVE NO. 1
GROUNDWATER PUMP AND TREAT/DISCHARGE TO POTW DETAILED COST

SITE 20, ALLEGHENY PIER (PIER 303)
NAS PENSACOLA, PENSACOLA, FLORIDA

Year	Capital Cost	Operation and Maintenance Cost	Annual Cost	Total Yearly Cost	Present-Worth Factor (i = 7%)	Present Worth
0	$249,490			$249,490	1.000	$249,490
1		$73,400	$67,920	$141,320	0.935	$132,134
2		$73,400	$66,760	$140,160	0.873	$122,360
3		$73,400	$66,760	$140,160	0.816	$114,371
4		$73,400	$66,760	$140,160	0.763	$106,942
5		$73,400	$66,760	$140,160	0.713	$99,934
6		$73,400	$66,760	$140,160	0.666	$93,347
7		$73,400	$66,760	$140,160	0.623	$87,320
8		$73,400	$66,760	$140,160	0.582	$81,573
9		$73,400	$66,760	$140,160	0.544	$76,247
10		$73,400	$66,760	$140,160	0.508	$71,201
11		$73,400	$74,120	$147,520	0.475	$70,072
12			$15,610	$15,610	0.444	$6,931
13			$15,610	$15,610	0.415	$6,478
14			$15,610	$15,610	0.388	$6,057
15			$15,610	$15,610	0.362	$5,651
16			$15,610	$15,610	0.339	$5,292

TOTAL PRESENT WORTH $1,335,399

TABLE C-5

GROUNDWATER REMEDIATION ALTERNATIVE NO. 2
GROUNWATER PUMP AND TREAT DETAILED COST

SITE 20, ALLEGHENY PIER (PIER 303)
NAS PENSACOLA, PENSACOLA, FLORIDA

	Quantity	Unit	Unit Cost	Total Cost
A. PRE-DESIGN DATA				
(1) Groundwater and product sampling and analysis				
(a) Groundwater and Product Sampling and Analysis Work Plan				
1 Jr. Level Engineer	40	hrs	$45	$1,800
1 Senior Engineer	8	hrs	$90	$720
Word processing	4	hrs	$35	$140
Technical Expert	6	hrs	$75	$450
Editor	2	hrs	$60	$120
CADD operator, 2 dwgs per report @ 8 hours per dwg	16	hrs	$60	$960
Reproduction & Shipping/binding	1	ls	$400	$400
(b) Groundwater Analysis for Contaminant Monitoring (assume 30 wells, 3 QC)				
Polycyclic Aromatic Hydrocarbons, SW-846 8310	33	ea	$150	$4,950
Total Lead, SW-846 Method 7421	33	ea	$15	$495
TRPH (FLPRO)	33	ea	$90	$2,970
(c) Groundwater Analysis for Natural Attenuation Parameters (assume 10 wells - no QA)				
Methane	10	ea	$85	$850
Ferrous Iron (Fe^{2+})	10	ea	$15	$150
Sulfate (SO_4)	10	ea	$15	$150
Nitrate (NO_3)	10	ea	$15	$150
(d) Expendables and Equipment Rental				
Gloves (2 box per event)	2	box	$10	$20
Teflon tubing (600 feet per event)	600	ft	$2.00	$1,200
Silicon tubing (200 feet per event)	200	ft	$2.00	$400
Shipping and supplies (tape, bubble wrap, ice)	1	ls	$400	$400
Rental of Horiba U-22 meter for conductivity, Oxidation-Reduction Potential, pH, dissolved oxygen, turbidity, and temperature.	10	days	$60	$600
Pumps for purging wells (assume 2 for 10 days)	20	days	$35	$700
First Aid kit	1	ls	$50	$50
Water/Hydrocarbon Interface Probe	10	days	$25	$250
Disposal of purge water, assume nonhaz., drums	8	ls	$150	$1,200
Car Rental w/fuel	10	ls	$65	$650
(e) Labor				
1 Technician, 10 days per sampling event @ 10 hour days	100	hrs	$30	$3,000
1 Geologist, 10 days per sampling event @ 10 hour days	100	hrs	$45	$4,500
Subtotal Pre-Design Data Collection Cost:				**$22,685**
B. GROUNDWATER TREATEMENT SYSTEM ENGINEERING DESIGN				
Engineering includes preparation of all submittals, such as HASP, Erosion and Sediment Control Plan, Waste Management Plan, Construction Documentation Report, System Operations Manual, "As Builts" and Start and Testing Report (20% of construction cost)	1	ls	$66,168	$66,168
Subtotal System Engineering Design Cost:				**$66,168**

TABLE C-5

GROUNDWATER REMEDIATION ALTERNATIVE NO. 2
GROUNWATER PUMP AND TREAT DETAILED COST

SITE 20, ALLEGHENY PIER (PIER 303)
NAS PENSACOLA, PENSACOLA, FLORIDA

	Quantity	Unit	Unit Cost	Total Cost
C. SITE PREPARATION				
(1) Mobilization	1	ls	$5,000	$5,000
(2) Construction office trailer	3	mo	$600	$1,800
(3) Trailer delivery, setup, removal	2	ea	$1,000	$2,000
(4) Storage bin	3	mo	$120	$360
(5) Construction office and storage area fencing, 40'x80'	240	ft	$18	$4,320
(6) Signs, temp fencing, barricades to seclude construction area	1	ls	$1,500	$1,500
(7) Pressure washer and water tank	1	mo	$504	$504
(8) Plastic sheeting, drums, pumps, hoses, supplies	1	ls	$2,000	$2,000
(9) Oversight Labor				
1 Jr. Level Engineer, 6 days @ 8 hrs/Day	48	hrs	$45	$2,160
1 Sr. Engineer, 16 hours	8	hrs	$90	$720
Subtotal Site Preparation				**$20,364**
D. GROUNDWATER TREATMENT SYSTEM CONSTRUCTION				
(1) Well Installation				
(a) Extraction wells, 10 wells @ 4'ID, PVC, 20' average bls	200	ft	$100	$20,000
(b) Electrical to pumps	1	ls	$3,000	$3,000
(c) Groundwater extraction pump, 2" submersible pump, 0.25-3 GPM, installed	10	ea	$1,200	$12,000
(d) Testing for Lead K_d (K_{oc} & foc)	1	ls	$3,500	$3,500
(e) Oversight and Sampling Labor				
1 Jr. Level Engineer, 4 weeks @ 40 hrs/wk	160	hrs	$45	$7,200
1 Sr. Engineer	32	hrs	$90	$2,880
Subtotal Well Installation Cost				**$48,580**
(2) Collection System				
(a) Piping for groundwater extraction wells to treatment sytem, 2" ID PVC (double walled), w/handholes, includes excavation and backfilling	1800	ft	$18	$32,400
(b) Electrician w/helper, 1 week @ 50 hrs/wk	200	hrs	$90	$18,000
(c) Oversight Labor				
1 Jr. Level Engineer, 1 week @ 50 hrs/wk	50	hrs	$45	$2,250
1 Sr. Engineer, 24 hours	24	hrs	$90	$2,160
Subtotal Piping and Equipment				**$54,810**

TABLE C-5

GROUNDWATER REMEDIATION ALTERNATIVE NO. 2
GROUNWATER PUMP AND TREAT DETAILED COST

SITE 20, ALLEGHENY PIER (PIER 303)
NAS PENSACOLA, PENSACOLA, FLORIDA

	Quantity	Unit	Unit Cost	Total Cost
(3) Treatment System				
(a) Electrical connection for treatment system (including electric poles, cable, transformer, phone line for telemetry)	1	ls	$15,000	$15,000
(b) Waterline Connection for Treatment System (includes underground piping and appurtenences)	1	ls	$5,000	$5,000
(d) Fencing, 50'x30', with manway and 14' gate	160	ft	$18	$2,880
(f) Gravity oil/water separator, 1000-gallon fiberglass	1	ls	$3,800	$3,800
(g) Equalization tank, 1000-gallon fiberglass	1	ls	$2,500	$2,500
(i) Liquid phase GAC, 5-20 gpm (Rental Unit)	1	ls	$1,200	$1,200
(j) Ion Exchange w/backwash, 5-20 gpm	1	ls	$110,000	$110,000
(l) Associated piping and valves @ 12% total treatment system cost	1	ls	$24,370	$24,370
(m) Flow meters	4	ls	$300	$1,200
(n) Flow indicators	4	ls	$150	$600
(p) Instrument panel, controls	1	ls	$10,000	$10,000
(q) Transfer and discharge pumps	4	ls	$1,000	$4,000
(r) Telemetry	1	ls	$10,000	$10,000
(s) Oversite Labor				
1 Jr. Engineer, 10 weeks @ 50 hrs/week	500	hrs	$45	$22,500
1 Sr. Engineer	160	hrs	$90	$14,400
Subtotal Treatment System Cost				$227,450
Subtotal Capital Cost				$440,057
E. GROUNDWATER TREATMENT SYSTEM O&M (annual)				
(1) Labor				
(a) Jr. Engineer, 12 hrs per month, system operating data, control	144	hr	$45	$6,480
(b) Sr. Engineer, 4 hours per month	48	hr	$90	$4,320
(c) Technician, 20 hrs per month	240	hr	$30	$7,200
(d) Project Mgr, 2 hrs per month	12	hr	$100	$1,200
(e) Electrician, 4 hours per year	4	hr	$75	$300
(2) POTW discharge fee	2,628	Kgal	$6	$15,768
(3) Misc. equip/supplies	12	mo	$800	$9,600
(4) Electricity (40 kW*24 hr/day*365 day/yr = 350,400 kWh/yr)	350,400	kWh	$0.08	$28,032
(5) Water (assume $500/year)	1	ls	$500	$500
Subtotal Groundwater System O&M				$73,400

TABLE C-5

GROUNDWATER REMEDIATION ALTERNATIVE NO. 2
GROUNWATER PUMP AND TREAT DETAILED COST

SITE 20, ALLEGHENY PIER (PIER 303)
NAS PENSACOLA, PENSACOLA, FLORIDA

	Quantity	Unit	Unit Cost	Total Cost
H. REMEDIAL ACTION MONITORING				
(1) Quarterly Groundwater Monitoring (Includes 4 monitoring wells, 3 GW extraction wells, and 1 QA)				
(a) Labor				
1 Technician, 5 days per sampling event @ 10 hour days	50	hrs	$30	$1,500
1 Geologist, 5 days per sampling event @ 10 hour days	50	hrs	$45	$2,250
Car Renta w/fuel (5 days per event)	5	ls	$65	$325
(b) Analysis				
Polycyclic Aromatic Hydrocarbons, SW-846 8310	8	ea	$150	$1,200
Total Lead, SW-846 Method 7421	8	ea	$15	$120
TRPH (FLPRO)	8	ea	$90	$720
(c) Expendables and Equipment Rental				
Gloves (2 boxes per event)	4	box	$10	$40
Teflon tubing (400 feet per event)	400	ft	$2.00	$800
Silicon tubing (50 feet per event)	50	ft	$2.00	$100
Shipping and supplies (tape, bubble wrap, ice)	1	ls	$250	$250
Rental of Horiba U-22 meter for conductivity, Oxidation-Reduction Potential, pH, dissolved oxygen, turbidity, and temperature.	4	days	$60	$240
Pumps for purging wells (2 pumps, 3 days rental per event)	6	days	$35	$210
First Aid kit	1	ls	$50	$50
Water/Hydrocarbon Interface Probe	5	days	$25	$125
Disposal of purge water, assume nonhaz., drums	8	ea	$150	$1,200
Subtotal Quarterly Groundwater Monitoring Costs				**$9,130**
(2) Treatment System Monitoring				
(a) Labor:				
1 Technician, 1 days per sampling event @ 10 hour days	10	hrs	$30	$300
Car Rental w/fuel	1	days	$65	$65
(b) Influent & Effluent Analysis (1 QA)				
Polycyclic Aromatic Hydrocarbons, SW-846 8310	2	ea	$150	$300
Total Lead, SW-846 Method 7421	2	ea	$15	$30
TRPH (FLPRO)	2	ea	$80	$160
Total Suspended Solids	2	ea	$15	$30
Total Dissolved Solids	2	ea	$15	$30
Total Iron	2	ea	$15	$30
Subtotal Quarterly Groundwater Monitoring Costs				**$580**
(3) Post-Active Remdial Action Monitoring (4 wells, 1 QA, for Natural Attenuation annually)				
(a) Labor:				
1 Technician, 3 days per sampling event @ 10 hour days	30	hrs	$30	$900
1 Geologist, 3 days per sampling event @ 10 hour days	30	hrs	$45	$1,350
Car Renta w/fuel	3	days	$65	$195
(b) Analysis				
Polycyclic Aromatic Hydrocarbons, SW-846 8310	5	ea	$150	$750
Total Lead, SW-846 Method 7421	5	ea	$15	$75
TRPH (FLPRO)	5	ea	$90	$450

TABLE C-5

GROUNDWATER REMEDIATION ALTERNATIVE NO. 2
GROUNWATER PUMP AND TREAT DETAILED COST

SITE 20, ALLEGHENY PIER (PIER 303)
NAS PENSACOLA, PENSACOLA, FLORIDA

	Quantity	Unit	Unit Cost	Total Cost
(c) Expendables and Equipment Rental				
Gloves	2	box	$10	$20
Teflon tubing	200	ft	$2.00	$400
Silicon tubing	50	ft	$2.00	$100
Shipping and supplies (tape, bubble wrap, ice)	1	ls	$250	$250
Rental of Horiba U-22 meter for conductivity, Oxidation-Reduction Potential, pH, dissolved oxygen, turbidity, and temperature.	3	days	$60	$180
Pumps for purging wells (2 pumps, 2 days rental)	4	days	$35	$140
First Aid kit	1	ls	$50	$50
Water level indicator	3	days	$25	$75
Disposal of purge water, assume nonhaz., drums	2	ls	$150	$300
Subtotal Quarterly Groundwater Monitoring Costs				$5,235
I. SUBMITTALS				
(1) Status/Monitoring Report				
(a) 1 Jr. Level Engineer	80	hrs	$45	$3,600
(b) 1 Senior Engineer	16	hrs	$90	$1,440
(c) Word processing	6	hrs	$35	$210
(d) Technical Expert	6	hrs	$75	$450
(e) Editor	6	hrs	$60	$360
(f) CADD operator, 4 dwgs per report @ 2 hours per dwg	8	hrs	$40	$320
(g) Reproduction & Shipping/binding: 20 reports, 100 pgs @ 20 copies	1	ls	$600	$600
Subtotal Status/Monitoring Report Cost:				$6,980
(2) Request for Discontinuation of Active Remediation				
(a) 1 Jr. Level Engineer	32	hrs	$45	$1,440
(b) 1 Senior Engineer	4	hrs	$90	$360
(c) Word processing	4	hrs	$35	$140
(d) Technical Expert	12	hrs	$75	$900
(e) Editor	4	hrs	$60	$240
(f) CADD operator, 2 dwgs per report @ 2 hours per dwg	4	hrs	$40	$160
(g) Reproduction & Shipping/binding: 20 reports, 100 pgs @ 20 copies	1	ls	$600	$600
Subtotal Request for Discontinuation of Active Remediation Report Cost:				$3,840
(3) Post-Remedial Monitoring Plan				
(a) 1 Jr. Level Engineer	40	hrs	$45	$1,800
(b) 1 Senior Engineer	4	hrs	$90	$360
(c) Word processing	4	hrs	$35	$140
(d) Technical Expert	4	hrs	$75	$300
(e) Editor	4	hrs	$60	$240
(f) CADD operator, 2 dwgs per report @ 2 hours per dwg	4	hrs	$40	$160
(g) Reproduction & Shipping/binding: 20 reports, 80 pgs @ 20 copies	1	ls	$520	$520
Subtotal Post-Remedial Monitoring Plan Cost:				$3,520

TABLE C-5

GROUNDWATER REMEDIATION ALTERNATIVE NO. 2
GROUNWATER PUMP AND TREAT DETAILED COST

SITE 20, ALLEGHENY PIER (PIER 303)
NAS PENSACOLA, PENSACOLA, FLORIDA

	Quantity	Unit	Unit Cost	Total Cost
(4) Post-Remedial Monitoring Report				
(a) 1 Jr. Level Engineer	32	hrs	$45	$1,440
(b) 1 Senior Engineer	2	hrs	$90	$180
(c) Word processing	2	hrs	$35	$70
(d) Technical Expert	2	hrs	$75	$150
(e) Editor	2	hrs	$60	$120
(f) CADD operator, 2 dwgs per report @ 2 hours per dwg	4	hrs	$40	$160
(g) Reproduction & Shipping/binding: 20 reports, 60 pgs @ 20 copies	1	ls	$450	$450
Subtotal Post-Remedial Monitoring Plan Cost:				$2,570
				$545,312

TABLE C-5.1

GROUNDWATER REMEDIATION ALTERNATIVE NO. 2
GROUNDWATER PUMP AND TREAT DETAILED COST

SITE 20, ALLEGHENY PIER (PIER 303)
NAS PENSACOLA, PENSACOLA, FLORIDA

Year	Capital Cost	Operation and Maintenance Cost	Annual Cost	Total Yearly Cost	Present-Worth Factor (i = 7%)	Present Worth
0	$440,057			$440,057	1.000	$440,057
1		$73,400	$69,080	$142,480	0.935	$133,219
2		$73,400	$66,760	$140,160	0.873	$122,360
3		$73,400	$66,760	$140,160	0.816	$114,371
4		$73,400	$66,760	$140,160	0.763	$106,942
5		$73,400	$66,760	$140,160	0.713	$99,934
6		$73,400	$66,760	$140,160	0.666	$93,347
7		$73,400	$66,760	$140,160	0.623	$87,320
8		$73,400	$66,760	$140,160	0.582	$81,573
9		$73,400	$66,760	$140,160	0.544	$76,247
10		$73,400	$66,760	$140,160	0.508	$71,201
11		$73,400	$74,120	$147,520	0.475	$70,072
12			$31,220	$31,220	0.444	$13,862
13			$15,610	$15,610	0.415	$6,478
14			$15,610	$15,610	0.388	$6,057
15			$15,610	$15,610	0.362	$5,651
16			$19,450	$19,450	0.339	$6,594

TOTAL PRESENT WORTH $1,535,282

APPENDIX D

FLORIDA DEPARTMENT OF ENVIRONMENTAL PROTECTION REMEDIAL ACTION PLAN SUMMARY

FLORIDA

DEP Form # 62-770.900(4)
Form Title: Remedial Action Plan Summary
Effective Date: September 23, 1997

Remedial Action Plan Summary

Site Name Allegheny Pier (Pier 303)
Location NAS, Pensacola, Florida
Media Contaminated: ☑ Groundwater ☐ Soil

FDEP Facility ID No. 179202973
Current Date / /
Date of Last GW Analysis 7 / 24 / 00

Type(s) of Product(s) Discharged:
☐ Gasoline Analytical Group
☑ Kerosene Analytical Group (Diesel)
- Estimated Petroleum Mass (lbs):
  - Groundwater 217
  - Saturated Zone Soil 10,512
  - Vadose Zone Soil 75,120
- Area of Plume 153,000 (ft^2)
- Thickness of Plume 11.5 (ft)

Groundwater Recovery and Specifications:
- No. of Recovery Wells 10
  - ☑ Vertical ☐ Horizontal
- Design Flow Rate/Well 0.5 (gpm)
- Total Flow Rate 5.0 (gpm)
- Hydraulic Conductivity 27 (ft/day)
- Recovery Well Screen Interval 10 (ft)
- Depth to Groundwater 6-8 (ft)

Method of Groundwater Remediation:
☑ Pump-and-Treat
- ☐ Air Stripper
  - ☐ Low Profile ☐ Packed Tower
- ☐ Diffused Aerator
- ☑ Activated Carbon
  - ☐ Primary Treatment ☐ Polishing

☐ In Situ Air Sparging
- No. of Sparge Points ______
  - ☐ Vertical ☐ Horizontal
- Pressure ______ (psi)
- Design Air Flow Rate/Well ______ (cfm)
- Total Air Flow Rate ______ (cfm)

☐ Biosparging
- No. of Sparge Points ______
  - ☐ Vertical ☐ Horizontal
- Design Air Flow Rate/Well ______ (cfm)

☐ Bioremediation
- ☐ In Situ ☐ Ex Situ

☐ Other ______

Method of Groundwater Disposal:
☐ Infiltration Gallery ☑ Sanitary Sewer
☐ Surface Discharge/NPDES ☐ Injection Well
☐ Other ______

Free Product Present: ☑ Yes ☐ No
- Estimated Volume 5,700 (gal)
- Maximum Thickness 17.04 (in)
- Method of Recovery (check all that apply):
  - ☐ Manual Bailing ☐ Skimming Pump
  - ☑ Other AFVR & Absorbent Socks

Method of Soil Remediation:
☐ Excavation
- Volume to be Excavated ______ (yds^3)

☐ Thermal Treatment ☐ Land Farming On Site
☐ Landfill ☐ Bioremediation
☐ Other ______

☐ Vapor Extraction System (VES)
- No. of Venting Wells ______
  - ☐ Vertical ☐ Horizontal
- VES - Applied Vacuum ______ (wg)
- Design Air Flow Rate ______ (cfm)
- Design Radius of Influence ______ (ft)
- Air Emissions Treatment
  - ☐ Thermal Oxidizer ☐ Catalytic Converter
  - ☐ Carbon ☐ Other ______

☐ Soil Bioventing
- No. of Venting Wells ______
  - ☐ Vertical ☐ Horizontal
- Design Air Flow Rate ______ (cfm)

☐ In Situ Bioremediation
☐ Other ______

Natural Attenuation:
- Method of Evaluation
  - ☐ Rule 62-770.690(1)(e), F.A.C.
  - ☐ Rule 62-770.690(1)(f), F.A.C.

Estimated Time of Cleanup: 5840 (days)
- Method of Estimation
  - ☐ Pore Volumes (no. of pore vols. = ______)
  - ☐ Exponential Decay (Decay Rate) ____ (day^{-1})
  - ☐ Groundwater Model
  - ☑ Other Engineering Evaluation

Estimated Cost:
- Est. Capital Cost (incl. install.) $ 249,500.00
- Est. O & M Cost (per year) $ 73,400.00
- Est. Total Cleanup Cost $ 1,335,400.00 (PW)